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EDITORIAL NOTES.

THE electric headlight for locomotives seems to possess advantages above that of merely giving the engineer a longer range of sight, in that the bright beam of light is plainly visible to those far in advance of the engine. It thus serves as a warning of its approach and may serve to avert collisions, unless trainmen become careless and, expecting it, delay sending back a flagman because the electric headlight was not seen.

THERE has been considerable criticism in marine circles, since the loss of the *Victoria*, on the practice of using longitudinal bulkheads. The objection is based on the ground that, in case of injury to the plating, a side compartment may fill and careen the vessel until her stability is lost and an overturn be the result, whereas with transverse bulkheads only, the vessel would merely settle by the head or stern. In our own construction, as exemplified by the *New York*, longitudinal bulkheads are used only along the machinery space.

IT must be exceedingly gratifying to those who have been actively engaged in the development of our naval and coast defense armament to meet with the success that is attending the trials of the new mechanisms. We were told that we were unable to build ships, make armor or construct guns, yet now we have the fastest cruiser in the world, our armor plate has resisting qualities that are unequalled, and our guns are the peers of the best in accuracy and carrying capacity; we must now bring our torpedo boats up to the standard and speeds reached by Yarrow, and then we will be up in every point. The submarine boat that will probably soon be constructed has raised great expectations, which bear all the signs of speedy fulfillment.

THERE has been a long and loud shout of mingled applause and astonishment over the success attained by the electrically driven boat on the Erie Canal. Why there should have been any surprise surprises us, for of all sensible methods that bear practicability upon their very face, the electrically propelled canal-boat takes the lead. These boats are built solely for carrying freight; speed is of a minor consideration, and the usual dangers of navigation are lacking. With mule or steam engine propulsion four men, to say nothing of the cook, are required for the crew of a boat that is driven day and night. With electricity two men suffice. Thus wages are halved, and surely the power should be supplied more cheaply than small individual engines could do it. So with cheaper power and wages divided by two, it would show a pretty state of things if the method were not a success.

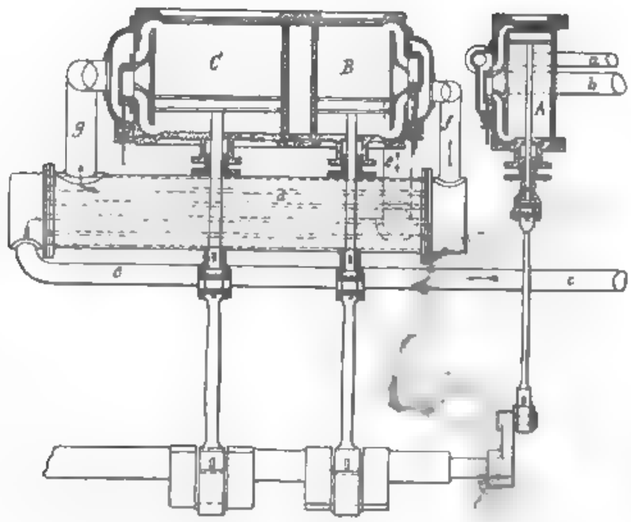
COMPOUND ENGINES.

WE have before us a circular and a letter from Mr. F. H. Wenham, of London, in which he describes a form of compound engine patented by him 30 years ago. In explaining his engine in the circular, he states the general theory on which it was constructed, and, in his letter, he theorizes on some of the more recent practice in the construction of compound locomotives. It will not be uninteresting or unprofitable, perhaps, to go back and see what was done then, and compare the practice of that time with what we are doing now.

In describing his engine, Mr. Wenham says that good economy has resulted from the use of high pressure—steam worked expansively before condensation; but it is well known that in a simple engine expansion can only be carried to a limited extent with advantage, as the practical effect is far below the theoretical value; this arises from diminished volume by loss of heat in expanding. The cooling by radiation may be prevented by steam-jackets or heating the cylinders above the steam temperature. But steam, in common with all gases, by the mere act of expansion falls in temperature with a loss of volume, and its whole bulk is instantly filled with aqueous particles which are thrown down as water.

The object of Mr. Wenham's improvements was, he said, "to maintain the full volume by conveying heat into the body of steam during expansion by the adaptation of heating-chambers through which the exhausted steam passed in its way from the small to the large cylinders. These chambers may either be heated by waste heat from the chimney, by a separate fire, or by means of superheated steam."

The following is an illustration of one of his inverted three-cylinder engines suitable for screw propulsion, which he described as follows:



Steam is led direct from the boiler into the first cylinder *A* through the pipe *a*. The exhaust steam returns by the pipe *b* into a heating-chamber (not shown in the engraving) placed

below the chimney, or heated by a separate fire; the steam was thereon raised to a very high temperature, but before entering the second cylinder it gave up a portion of its surplus heat to the steam on its way from the second cylinder *B* to the third one *C*, as follows: the highly superheated steam from the first cylinder *A* is returned by the pipe *C C* through a set of tubes in the heating-chamber *d*. The exhaust steam from the second cylinder *B* passes into this chamber by the pipe *e* and is then exposed to the exterior of the tubes, and is thereby heated in its passage to the third cylinder *C*, to which it is conveyed by the pipe *g*, and from which it is finally condensed by a surface condenser. The inter-heater for the third cylinder is thus brought close to its work, is not liable to injury from excess of heat, and avoids the necessity of having two heaters.

In the same circular Mr. Wenham illustrates a two-cylinder non-condensing portable engine, the inter-heater of which is placed inside of the smoke-box, and consists of a cylindrical-shaped vessel with tubes extending through it parallel with its axis. The exhaust steam is conducted to this heating-chamber in the smoke-box, where it is reheated, and is thus increased in volume, and is then conveyed to the large cylinder, where it is expanded the second time.

In view of the great amount of ingenuity which has been exercised in the design of compound locomotives of late years, it will be interesting to compare what has been done since Mr. Wenham patented his engine and exhibited it and received a medal from the great Exhibition of 1862, when, he says, "every one was scared at the boiler pressure—from 150 to 200 lbs. per square inch—that he deemed necessary."

When steam expands in a cylinder and does work by acting against a moving piston it loses heat; the loss of heat, too, is in proportion to the work done. If we had a vertical cylinder—say 100 in. in diameter—and a quantity of steam of, say, 200 lbs. pressure and of 388° temperature, sufficient to fill the cylinder one-quarter full, was permitted to flow freely into and expand into the whole volume of this cylinder so as to fill it full, and there was no loss of heat by conduction or radiation, the final pressure would be, roughly stated, 50 lbs., and its temperature would be 298°. Let it be supposed that there is a piston in the cylinder and that it is loaded with a weight of 200 tons, and that when the steam flows into the cylinder it must raise the piston and its load, and that when the cylinder is one-quarter full the supply of steam is cut off and it is then allowed to expand, and will thus continue to raise the loaded piston to the end of its stroke, or as far as the reduced pressure of the steam will permit; it would then be found that there was a greater loss of heat when the steam was doing this work than there was when it expanded in the cylinder without raising a weight. We will not now go into the question of how much heat would be lost as a consequence of raising the load; all that it is intended to make plain here is that in doing this some of the heat of the steam disappears and is lost, and is in reality converted into work. Now, what occurs in a compound engine? The steam is admitted into the high-pressure cylinder, and by its expansive action pushes the piston before it against the resistance of the engine. In doing this the steam loses heat, which is transformed into work, and, consequently, partial condensation occurs in the cylinder unless the steam admitted contains a surplus of heat, or is superheated, as it is termed. As we are engaged in an elementary elucidation, this may be explained. To do this, let it be supposed that steam of 200 lbs. pressure (above the atmosphere) is admitted to the high-pressure cylinder. The temperature of this steam, if it were saturated—that is, if it were generated in contact with water—would be about 388°. Now, as soon as the steam loses any of this heat its pressure will fall—that is, as soon as it exerts a pressure on the piston some of its heat is converted into work; or, if heat is lost by conduction or radiation, the pressure of the steam will also fall. To provide for this loss, before steam is admitted to the cylinder it is sometimes superheated—that is, it is heated without being in contact with water—to a temperature higher than 388°. The steam may, therefore, lose this surplus heat without being very materially lowered in pressure. But there are some serious practical objections in working steam of such high temperature, growing out of the difficulty of keeping the inside surfaces of the cylinders, the piston-rod and valves lubricated. For this reason superheating has never been very generally adopted.

It would, however, seem as though the method adopted by Mr. Wenham, of reheating the steam after it had done its work in the high-pressure cylinder, and after its temperature and pressure are reduced, was not open to the objections to superheating very high-pressure steam.

Mr. Wenham in his letter, to which we have referred, says:

Mr. Lancaster, of the Kirkler's Hall Coal & Iron Works, for the purpose of testing this system thoroughly ran his steam from the high-pressure cylinders into an inter-heater consisting of another boiler, with a separate fire; he informed me that the increase in power and corresponding economy of fuel was most remarkable when this second fire was alight. Unfortunately Mr. Lancaster died without recording the particulars of his experiments.

In discussing the advantage of inter-heaters, Mr. Wenham says further:

If the steam from the first cylinder is expanded through a cold chamber in its passage to the second cylinder, or from that to the third, the result will be a positive loss, as the intermediate receivers will partly act as condensers, and if set under the exhaust will speedily become choked with water. This has been partly prevented by enclosing the inter-chamber with a steam-jacket; but this again affords no economy in the ultimate result, as we must still have external condensation. The steam-jacket of a working cylinder prevents internal condensation, caused by the fall of temperature by expansion from a high pressure to that below the atmosphere, and the consequent loss from alternate heating and cooling of the surface. In the inter-heaters of compound engines the pressure should be obtained as uniform as possible by giving as large a capacity as practicable. As to the capacity of the heating chambers, the rough rule may be taken—make them as large as circumstances will allow; and much the same principle will apply to the heating surface. If this is small, the effect is scarcely appreciable, and water constantly settles in the bottom, showing that there is no increase of volume such as is derived from steam thoroughly dried.

Inter-heaters constructed with straight tubes, with the ends expanded into the tube-plates in the usual way, have been found to be very troublesome from leakage, as dry steam is ineffective in preventing differences of temperature in the parts. Consequently some tubes get hotter than others, causing the joints to leak. If an entire tubular arrangement is used, the tubes should have a considerable curvature, as a horse shoe shape, or coil, or, preferably, the tubes should be attached at one end only, as in a Field boiler, the steam passing down to the bottom through light inner conducting tubes, or outside of these and up in the interior.

The designers of compound locomotives do not seem to have availed themselves of the advantages of inter-heating the steam to the extent which is possible. In the new edition of Wood's book on Compound Locomotives it is said that "the drop of pressure into the receiver represents an actual loss of efficiency, since it occurs by the expansion of the steam without doing useful work."

The authors of this excellent book seem to be a little uncertain of their ground in discussing this subject. In one place (page 54) it is said:

Superheating in the receiver of a compound locomotive is practically impossible unless the smoke-box temperature is above what it should be for good economy in the boiler, for the reason that the steam passes through the receiver when the engine is at speed at a rate that would make it impossible to collect enough heat to re-evaporate all of the moisture in the steam, much less to cause a superheat. . . . . It is true that the temperature of the smoke-box is about 600°, quite sufficient to produce a substantial superheat, if the steam remained in the receiver long enough to permit it; but at 200 revolutions per minute, which is an ordinary velocity for a locomotive, there are 400 exhausts into the receiver per minute. If the receiver is about twice the volume of the low-pressure cylinder up to cut-off, then each cubic foot of steam remains in the receiver about $\frac{1}{200}$ part of a minute, or about $\frac{1}{3}$ of a second, a much too short a time to permit of superheat.

The latter statement seems to be only an assumption. We might argue in the same way about the action of the hot gases in the flues of the boiler. The rapidity of the movement of the gases in the tubes is so great that their period of contact with any given surface it might be said is infinitely short, and yet in that period they do transmit their heat to the water outside. If the steam remains in the receiver too short a time to absorb heat, the obvious remedy is to increase the size of the receiver or its heating surface. Doubtless if a current of steam flows so as to impinge against a hot surface of metal, it will always absorb a very considerable amount of heat, no matter how short the period of contact is. Doubtless, too, the larger the heating surface in proportion to the volume of steam, the greater will be the amount of heat which will be absorbed,

On page 82 of the book from which we have quoted, it is said:

> Smoke-box temperatures vary from 400 to 1,200°, according to the forcing of the engine and the length of the tubes. Recently there has been a decrease in smoke-box temperatures, with new designs of locomotives, resulting from the use of larger fire-boxes and longer tubes, and it is probable that smoke-boxes will be run at a lower temperature in the future than they now are; but in no case will they reach so low a temperature as to remove all value for the purpose of re-evaporating moisture in the steam in the receiver of two-cylinder receiver compound locomotives.

Again it is said on page 276:

> The amount of re-heating in the receiver will vary with the temperature of the smoke-box and the speed of the engine. By using a large copper receiver with a volume not less than three times that of the high-pressure cylinder, such re heating as it is practicable to gain may be had. As the re-heating in the receiver is done by the waste heat in the furnace gases, all the re-heating that takes place is clear gain, and in this way it differs from re-heating by boiler steam.

Mr. Dean, in designing the Old Colony compound engine, seems to have availed himself of the advantage of re-heating the steam to a greater degree than any other designers have thus far done. It seems as though there was here a much-neglected means of economy. If the only difficulty is in getting a re-heater large enough, then it would seem as though it might be worth while to alter materially the shape and dimensions of the smoke-boxes to get room for a re-heater of sufficient capacity. If compound locomotives come into general service in some places and for some kind of traffic—and they probably will—re-heaters would seem to have a very important function to perform in increasing the economy of the engine and in reducing the fuel consumption.

THE SECRETARYSHIP OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

THE annual election for officers of this Society will, according to custom and the provisions of its constitution, be held this month. Among the elective officers of the Society is the Secretary. A comfortable salary is attached to this office, and the position gives the incumbent more or less distinction and consideration. The result is that periodically the Society is thrown into a sort of electioneering paroxysm by different candidates for the position and their friends. At present the exacerbation is very severe, judging from the number of circulars issued and the tense state of mind which some of the members appear to be in when the subject of the coming election is mentioned. There are two rival candidates in the field, one the present Secretary and his assistant. With reference to the merits of the contest, or rather the contestants, we do not propose to have anything to say, excepting that a change in the incumbent of the office seems to be very ill advised, unless there is some adequate reason for it.

But it may be said that this sort of Kilkenny fight, coming on periodically, is, to say the least, unseemly, and is another illustration of what seems to be a characteristic of civil engineers—that is, an inability to agree or co-operate with each other. It nearly always happens when any line of action is proposed in this Society that there is at once a declaration of war, and the membership divides not only into two parties, but at times into half a dozen, and, figuratively speaking, they dismember the tripods of their levels and brandish the separate legs, like shillalahs, over the heads of each other.

Speaking dynamically, there is a great waste of energy, which, instead of being employed in useful work, develops into scandal. Now what is the cure? Obviously, the evil is the consequence of the Secretaryship being an elective office. The periodic feline contests precede or accompany the election, Do away with the election, and the occasion of the general row will also be abolished.

In other words, the evil would be cured by making the Secretary an appointee of the Board of Directors instead of an elective officer. This is now the case in the American Society of Mechanical Engineers, and also in the Master Car-Builders' Association. It sounds like a bull to speak of the *belligerent* members of the Society of *Civil* Engineers, but the expression describes an existing fact. For their benefit we reprint the following extract from the constitution of the latter Association. That instrument provides that:

> "A Secretary, *who may or may not be a member of the Association*, shall be appointed by a majority of the Executive Committee at its first meeting after the annual election, or as soon thereafter as the votes of a majority of the members of the Executive Committee can be secured for a candidate. The term of office of the Secretary thus appointed, unless terminated sooner, shall cease at the first meeting, after the next annual election succeeding his appointment, of the Executive Committee organized for the transaction of business. Two-thirds of the members of the Executive Committee shall, however, have power to remove the Secretary at any time. His compensation, if any, shall be fixed for the time that he holds office by a vote of a majority of the Executive Committee. He shall also act as Secretary of the Executive Committee."

It will be seen that this provision makes the Secretary the servant of the Executive Committee, as he should be. They are responsible for the conduct of the Association, and should have entire control over the Secretary and his action, and have the power of appointing and removing him. At present the Secretary of the Society of Civil Engineers is elected in the same way as the members of the Board of Directors and other officers are, and he has, consequently, co-ordinate power and, to some extent at least, is beyond their control. His position should be one which would compel him to do the bidding of the Board. The members of it generally are the only persons in the Society who really know whether his duties are satisfactorily and efficiently performed. A membership scattered over thousands of miles cannot, in the nature of things, know how the daily routine in the office on Twenty-third Street, New York, is performed, as well as the members of the Board of Directors, who are frequent visitors, and who are, or should be, intimately acquainted with the business of the Society.

It will also be noticed that, in the provision quoted above, that the Secretary "may or may not be a member of the Association." This was incorporated in it for the reason that it was thought that at times it might be possible to find a better Secretary outside of the Association than could be found in it. It is said that Mr. Forrest, the well-known Secretary of the Institution of Civil Engineers, and perhaps the most efficient person in such a capacity that could be named, was not a member of the Institution when he was appointed. It seems like folly to select a man in the Society for the position who would be less efficient than some other person outside of it.

It is also true that a Board of Directors, who have assumed the responsibility for the conduct of the Society, will be more likely to select a competent person to perform the executive duties of the Secretaryship than a caucus will, composed of

members with less knowledge of the requirements of the office and no responsibility for the conduct of affairs.

The provision of the constitution of the Car-Builders' Association was adopted in 1872, and since then there has been but one change in the Secretaryship, due to the resignation of the first incumbent. The change was made quietly by the Board of Directors, and without the knowledge of the rest of the Society, no electioneering, log-rolling, nor publication of inflammatory circulars, of which the members of the Civil Engineers' Society now receive so many. A new incumbent was appointed at the same meeting at which the resignation of his predecessor was received, and the now appointee has held the office since 1889.

Another contingency is provided for in the constitution of the Car-Builders' and Mechanical Engineers' Association—that is, that the term of office ceases "at the first meeting after the next annual election succeeding his appointment." The object of this provision is to guard against a continuance of an incumbent of the office when there are reasons for a change, merely because no one is willing to assume the responsibility of a removal. By the provisions referred to the Secretary's appointment ends when a quorum of the newly elected Board meets. This provision also minimizes the chances of scheming for the office, because it is not known until after the general election of the Association who will compose the new Board.

By adopting a provision similar to that under which the Mechanical Engineers and Car-Builders have been working for ten years or more, without a single stormy election—to which the Civil Engineers are from time to time subject—the latter might avoid undignified brawls like the one which is now on.

NEW PUBLICATIONS.

THE publishers of *The Railway Master Mechanic* announce that beginning with January, 1894, the name of that paper will be changed to *Railway Engineering and Mechanics*. We invoke for our contemporary, under its new name, the favor of the goddess of good luck, and that its career may be more prosperous than that of most technical newspapers promises to be in the immediate future.

GOLDTHWAITE'S GEOGRAPHICAL MAGAZINE for July to September, which is published at 79 Nassau Street, New York, reaches us with an announcement that, owing to annoyances unavoidable, caused by labor troubles and the panicky condition of the times, there have been delays in getting out this publication, but that, beginning with January, 1894, it will appear regularly.

HANDBOOK OF INFORMATION OF THE RENSSELAER POLYTECHNIC INSTITUTE, Troy, N. Y. 24 pp., 9 × 6 in.

This is a pamphlet beginning with a brief history of the school, followed by a description of its location, grounds, buildings, and courses of instruction. It is illustrated with engravings of exterior and interior views of the buildings, and, we were about to write, of the students, but unfortunately only exterior views of these have thus far been found to be practicable. The purpose of the pamphlet is obvious.

IMPERIAL UNIVERSITY OF JAPAN (Teikoku Daigaku). The Calendar for the Year XXV-XXVI Meiji (1892–93). Tokyo: Published by the University. 203 pp., 7¼ × 5¼ in.

Like most other similar publications, this begins with a historical summary of the University. The next chapter gives the General Regulations for the Colleges, which is succeeded with a description of the courses of study which may be pursued. An appendix contains a statement of the condition of the University during the year and of the plans for the next, and ends with several large folded maps showing the location of the grounds and buildings. All in all, college calendars or catalogues in Japan are not very unlike those here, excepting that the former contain more unpronounceable names and words than ours do.

A FIELD BOOK FOR CIVIL ENGINEERS. By Daniel Carhart, C.E. 281 pp., 7 × 4 in. Boston: Ginn & Co.

This book, the Author says, "is written for students of civil engineering, and to satisfy a demand, often expressed by field engineers, for a manual convenient in size, containing the desired information, systematically arranged, fully illustrated, and easy of reference."

The various chapters treat of Reconnoissance, Preliminary Survey, Simple Curves, Compound Curves, Miscellaneous Problems, Construction, Frogs and Switches. These chapters are succeeded by the usual tables found in such books.

It is of convenient size, bound with a flap, and is clearly and simply written.

THE TRANSITION CURVE, *by Offsets and by Deflection Angles*. By C. L. Crandall, C.E. 64 pp., 6¼ × 4¼ in. New York: John Wiley & Sons.

This little book is divided into two parts, in which the Theory and the Practice of Laying out Transition Curves for railroads is discussed. It contains a good deal of tough-looking mathematics, and the casual reader wonders whether it is all needed for the elucidation of the subject, and also how the late Mr. Trautwine would have treated the subject had he written a book on it in his admirably clear style.

The Author says his book is "primarily intended for the use of civil engineering students. It is believed that the complete set of tables given will render the methods at least as rapid and convenient in actual use in the field as the more restricted or approximate ones now in use."

THE MECHANICS OF HOISTING MACHINERY, *including Accumulators, Excavators, and Pile-Drivers*. By Dr. Julius Weisbach and Professor Gustav Herrmann. Translated by Karl P. Dahlstrom, M.E. 329 pp., 5¾ × 9 in. Macmillan & Co., London and New York.

This is a translation of the section on Hoisting Machinery, made from Professor Herrmann's revised edition of Weisbach's great work on Engineering Mechanics. The engravings are apparently made from the original wood-cuts, and are of the usual excellent style characteristic of German technical literature. The different chapters treat of Levers and Jacks; Tackle and Differential Blocks; Windlasses, Winches, and Lifts; Hydraulic Hoists, Accumulators, and Pneumatic Hoists; Hoisting Machinery for Mines; Cranes and Sheers; Excavators and Dredges and Pile-Drivers. All the problems in the book are treated with what seems to be an excessive amount of mathematics, with Greek notation often printed in the smallest and most confusing type. The book is admirably printed on good paper, but will be useful only to those who are well up in mathematics.

ADDRESSES DELIVERED BEFORE THE WORLD'S RAILWAY COMMERCE CONGRESS, *held in Chicago, Ill., June 19–23, 1893, under the auspices of the World's Columbian Auxiliary of the World's Columbian Exposition*. Official Report. 265 pp., 8¼ × 6 in. Chicago: The Railway Age and Northwestern Railroader.

The title of this volume indicates its general character. That of the separate addresses and their subjects is not so easy to describe. The subjects are grouped under five general heads: 1, Opening Addresses; 2, Railway Law and Legislation; 3, Railway Management and Operation; 4, Railway Employés; and 5, Railway History and Development. As there were 35 different addresses and papers, we have not room for their titles and the names of their authors even, much less can we convey any sort of idea of the general character of the addresses, which range all the way from the Constitutional Guarantees of Railway Properties and Franchises against Legislative Spoliation to discussions of the merits of Safety Appliances and Methods of Heating and Lighting Cars. Candor compels us to say that the book is somewhat dreary. Many of the papers have distinctly the character of "compositions," written to order or by request, and not because the authors had anything of special value to say. Not a few of the addresses are on subjects on which the authors were not experts, and there are unmistakable indications of what is called "collating" in some of them. An invitation to read a paper at a World's Congress is hard to resist, hence the size of this volume. It is, of course, true and reasonable that when so many distinguished persons are asked to take part in a conference of this kind, that much that is interesting and valuable will

be evolved; but a few of the addresses before us, like the stocks of some railroad companies, are overmuch diluted. As the book contains over 150,000 words, it is filling, but not always satisfying.

THE FIRST STEAM SCREW PROPELLER BOATS TO NAVIGATE THE WATERS OF ANY COUNTRY. By Francis B. Stevens. From the Hoboken Ferry Company, Hoboken, N. J. 30 pp., 9¼ × 6¼ in.

This pamphlet is a reprint from the Stevens Indicator, and describes the experiments and actual performance of Colonel John Stevens in applying a screw propeller and steam power to navigation on the Hudson River from 1802 to 1806. Incidentally a historical sketch is also given describing what had been done in this direction previous to that date. The pamphlet contains a number of very excellent engravings, made from photographs showing the engine, boiler, and propellers which Colonel Stevens constructed at Hoboken in 1804 and applied to a boat at that time. The boat has been twice reconstructed; the third one was sent to the Columbian Exhibition. The engravings show several different views of the engine separate from and several in its position in the boat. Besides describing what Colonel Stevens did, the historical sketch contains much of interest relating to the achievements of other inventors. It is from sketches like this that the history of the future must be made.

POOR'S DIRECTORY OF RAILWAY OFFICIALS. *Eighth Annual Number*, 1893, *Containing Lists of the Officers of all Railways in North America and of the Leading Organizations Auxiliary to the Railway System; Lists of Officers of South American and Hawaiian Railways, etc.* 511 pp., 8¾ × 5¾ in. Compiled from official information. Poor's Railroad Manual, 70 Wall Street, New York.

We are somewhat late in noticing this volume, and owing to the large number of books sent us for review, cannot atone for the lateness of our notice by fully describing the merits of this number. It has grown, of course, in somewhat the same or greater proportion than our railroad system has. It is replete with information, of which it may, however, be said, as the Caledonian did of Johnson's Dictionary, "It is interesting reading, but a little hard to remember." In the circular accompanying the volume it is said that "a new feature now first introduced into this book is a classified index to the leading manufacturers of railway appliances, which is the most complete and comprehensive buyers' guide ever compiled for the use of railway officials. In this guide we have indexed you under numerous headings appropriate to your business, details of which we will furnish you on application." True to their promise, the publishers have indexed "us" under the appropriate title, and doubtless many of our readers will find that they are similarly favored.

THE CORLISS ENGINE, by John T. Henthorn, and ITS MANAGEMENT, by Charles D. Thurber. Edited by Egbert P. Watson. Third Edition, enlarged. 96 pp., 6 × 4¾ in.

As will be seen from the above transcript from its title-page, this book has a sort of composite authorship. Some of the language in it also has a "composite" character, as will be seen from the following extract:

> The gradual development and appreciation of the Corliss system during the past 36 years has grown to such proportions as to trace this Corliss principle in the design and build of a large proportion of the engines used in our manufacturing industries in this and foreign countries, and I may say that its use for maritime purposes is better appreciated to-day, and will be still better in years to come, by the few years of experience that it has been subjected to to determine its value over other systems now in use for that purpose.
> During this long period of increasing usefulness, it has been the rise and fall of the most sanguine expectations of many inventors for its honors. Sufficient evidence has been gathered by steam users throughout, I may say, the civilized world, as a criterion of its merits; and this has been established by facts covering economical performance for years rather than by claims based upon theory.

This is a little mixed. The book, however, is of the type called "practical," and for some reason in books of that kind clear, lucid English does not seem to be regarded as essential. The various chapters treat of Steam Jacketing, Indicator Cards, the Governor, Valve-Gear and Valve Setting, Lubrication, the Air Pump and its Management, Care of Driving-Gears, Heating by Exhaust Steam, and Engine Foundations.

PRACTICAL INSTRUCTIONS RELATING TO THE CONSTRUCTION AND USE OF THE STEAM ENGINE INDICATOR. PART I. *General Design and Construction of Steam Engine Indicators. Special Design, Construction, and Use of the* CROSBY INDICATOR, *with Directions for its Attachment and the Construction of Suitable Mechanism for Operating the Drum, together with full Instructions for taking Diagrams, Computing Horse Powers, etc., to which is added complete Directions for Using Amsler's Polar Planimeter, and Professor C. H. Peabody's Calorimeter.* [illegible] II. *By Albert F. Hall, S.B. Brief Article on the* [illegible]*neration of Steam, and Correct Methods for making Engine and Boiler Tests, with full Numerical Applications. Together with Numerical Examples Illustrating Various Ways of Calculating the Steam Consumption from the Diagrams, etc.* 95 pp., 7 × 4½ in. Boston: The Crosby Steam Gauge & Valve Company.

The above transcript from the title-page of the excellent little book before us is so long that there is little room for other notice. As it is fully descriptive of the character of the publication, it is perhaps unnecessary to add much more. In the preface the publishers say:

> The purpose of this book is to enable the engineer of ordinary ability to understand: First, the design, construction, and use of the Crosby Steam-Engine Indicator. Secondly, to make suitable preparation for applying it to a steam engine, including the mechanism for operating the paper drum. Thirdly, to take diagrams, read them intelligently, and, after some experience, deduce from them such information as to the working of an engine as a good instrument skillfully applied and handled is capable of revealing to the studious and observing mind.

All this the book does excellently well, and we regret that we cannot devote more space to pointing out its merits. Part II is a very clear elucidation of the phenomena attending the generation of steam, the calculations involved in engine and boiler tests, and directions for making them. This little volume is another illustration of the fact that in many cases the best literature on some engineering subjects is found in trade catalogues.

INTERNATIONAL MARITIME CONGRESS. *General Report and Minutes of Proceedings of Second Meeting held at the Institution of Civil Engineers, London*, 1893. Printed and sold by Unwin Brothers, 27 Pilgrim Street, E. C., London. Five volumes. 10¼ × 6¾ in., 46, 196, 144, 113, and 211 pp.

In an Introductory Note to the General Report the following account of the origin and genesis of this Congress is given:

The first meeting was held in Paris in 1889, under the title of "Congrès international des travaux maritimes," and the proceedings were considered so satisfactory that, at the close of the sittings, the members unanimously determined to make the Congress permanent by the appointment of a "Permanent Commission," with its headquarters in Paris.

> This Commission comprises representatives of 13 European countries. The duty of the Commission is to arrange for meetings of the Congress at suitable periods in the different countries of Europe. It was decided in July, 1892, that the second meeting should be held this year in London, and, to give effect to that decision, an Organizing Committee was formed in England, under the presidency of Lord Brassey. . . . The meetings of the Congress for the reading and discussion of papers were held in sections, among which the subjects to be considered were divided as follows: I, Harbors and Breakwaters; II, Docks; III, Shipbuilding and Marine Engineering; IV, Lighthouses, Buoys, Fog-Signals, etc. The Proceedings of the four Sections are published in separate volumes.

We have not time nor space to give even the titles of the interesting papers and discussions thereon in these volumes, but, with the exception of Section III, can only enumerate them. On Harbors and Breakwaters there are 13 papers, and discussions on about half of them. On Docks there are 11 papers, only a few of which appear to have been discussed. On Lighthouses and Buoys there were 10 papers, and on Shipbuilding and Marine Engineering there were the following papers: Steam Communication with the Continent Past and Present, by A. E. Seaton; Ocean Passenger Steamships, by J. H. Biles; a Description of the New Sand-Pump Dredger for the Mersey Docks and Harbor Board, by A. Blechynden; Marine Boiler Construction, by C. E. Stromeyer; and on Shipowners and Shipbuilders in their Technical Relationships, by A. Denny. There is room for regret, both on the part of our readers and the writer, that we cannot dwell on the points of interest in these papers, but it must be remembered that the area of the pages of THE AMERICAN ENGINEER is limited, whereas that of current engineering literature is boundless.

We will only linger on one point more. The style in which these reports are printed is an example which all secretaries might imitate with advantage. The print is long primer leaded, and measures 4 × 7 in. The inside margin is 1¼ and the outside 1½ in., and the volumes are bound so as to open easily. Reading them is thus a luxury.

THE SCIENCE OF MECHANICS. *A Critical and Historical Exposition of its Principles.* By Dr. Ernest Mach, Professor of Physics in the University of Prague. Translated from the second German edition by Thomas J. McCormack. 534 pp., 7¼ × 5¼ in. Chicago: The Open Court Publishing Company.

The general character of this book is indicated in the author's preface, in which he says:

"The gist and kernel of mechanical ideas has in almost every case grown up in the investigation of very simple and special cases of mechanical processes; and the analysis of the history of the discussions concerning these cases must ever remain the method, at once the most effective and the most natural for laying this gist and kernel bare. Indeed, it is not too much to say that it is the only way which a real comprehension of the general upshot of mechanics is to be attained.

"I have framed my exposition of the subject agreeably to these views."

The book may be said to be a history and analysis of the evolution of the Science of Mechanics. Whether or not it be true, as the author asserts, that it is only by an analysis of the history of the discussions from which the present science of mechanics has been evolved that a real comprehension of the "upshot of mechanics is to be attained," his book is nevertheless a very interesting and instructive one.

The subjects treated of in the different chapters are: I, The Development of the Principles of Statics, in their application to the lever inclined plane, composition of forces, virtual velocities, fluids, gaseous bodies, and a retrospect of the development of statics.

II, The Development of the Principles of Dynamics, with an account of Galileo's, Huygens's, and Newton's achievements, and the latter's views of time, space, and motion, and a critique of the Newtonian enunciations. A discussion of the principles of reaction, the concept of mass, and of the development of dynamics is included in this chapter.

III, The Extended Application of the Principles of Mechanics and the Deductive Development of the Science. The separate subjects treated in this chapter are the Newtonian principles, formulæ and units of mechanics, conservation of momentum, center of gravity and of areas, laws of impact, D'Alembert's principle, *vis viva*, least constraint, least action, Hamilton's principle, and some applications of the principles of mechanics to hydrostatic and hydrodynamic questions.

IV, The Formal Development of Mechanics, including isoperimetrical problems; theological, animistic, and mystical points of view in mechanics; analytical mechanics and the economy of science.

V, The Relations of Mechanics to Physics and to Physiology.

The book is well printed, and is illustrated with 235 engravings, mostly diagrams, and has that commendable addition, a good index.

BRITISH RAILWAYS. *Their Passenger Services, Rolling Stock, Locomotives, Gradients, and Express Speeds.* By J. Pearson Pattison. 252 pp., 8½ × 5¾ in. Cassell & Co., Limited.

The character and scope of this book is perhaps best described in its own preface, in which the Author says:

The subject of railway traveling is alone considered, and that mainly from a statistical standpoint. Particulars of the commercial speed of all the leading British lines are given, followed by a description of the locomotives at present used in express traffic, the gradients over which they run, and the actual work they perform. Prefaced to this detailed description of the various systems is an introductory section dealing in the most general manner with the subject of railway traveling in this and other countries, and commenting briefly on the train services, the rolling stock, and the safety appliances used in passenger trains working not only in this country, but on the Continent, and in the United States of America.

The book is divided into three parts, the first consisting of four sections on Speed and Punctuality, Passenger Rolling Stock; Safety and Safety Appliances; Locomotives, Gradients, Curves, Train Loads, and Train Timing.

In Part II the British lines are described in considerable detail. To quote again, this time from "Explanatory Notes to Part II," the author says: "The length of each system is given approximately, the traveling facilities are described, and punctuality and local train services are discussed. Following this, under the sub-title of Rolling Stock and General Accommodation, the safety appliances, stations, etc., of each company are briefly described."

Locomotive work is discussed under the separate sub-titles of Speed, Gradients, Locomotives, Actual Performances, and under these are considered respectively "the demands made on the locomotive in the way of speed, the contour of the line over which these speeds are to be maintained, the machines actually doing the work indicated in the previous sections, and the manner in which these machines actually perform this work, as illustrated by a very large number of examples observed, personally, in actual daily practice." Profiles of all the lines, and speed recorder diagrams of some of them, and outline engravings showing the principal features of the leading type of locomotive of each line, are given. There is also a tabular statement giving the principal dimensions and weights of different classes of engines used on the respective lines.

In the last section, or Concluding Remarks, the following topics are discussed: The Highest Speed ever Recorded; The Fastest Train in the World; The Race to Edinburgh; Competitive Traffic and Uphill Running.

The book is admirably printed, and is bound so that it opens easily, which is characteristic of most English binding, whereas in reading some American books one often feels the need of a "jimmy" to pry them open.

COMPOUND LOCOMOTIVES. By Arthur Tannatt Woods. Second edition, revised and enlarged by David Leonard Barnes. 330 pp., 5¾ × 8¾ in. Chicago: The Railway Age and Northwestern Railroader.

As the above transcript of the title-page of this book indicates, it is a recast of Professor Woods's former book. The new edition is nearly twice the size of the original, is printed in larger type, and is generally much improved. In the preface to the new edition it is said that "the aim has been to add all important developments since the first edition, and to describe not so much the plans of various inventors, as to place before the reader the actual construction and practical value of compound locomotives that have been built and put into service. . . . There has been added further consideration of the more important functions of compound locomotives, based on analysis of data and indicator cards, which were not available for the first edition. . . . The first 10 chapters have been prepared with special reference to students. Chapter XI. to XX., inclusive, refer more particularly to the different types of compound locomotives, and have been arranged for designers of locomotives. Chapters XXI. to XXIII. are intended to place before the reader an unprejudiced comparison of the different types, and to indicate why double expansion is expected to be more economical than single expansion for locomotives."

The first eight chapters of the book treat of the Distribution and Action of the Steam in the Cylinders. The ninth chapter is on the Starting Power of Compound Locomotives; the tenth on Condensation in the Cylinders; the eleventh, twelfth, and thirteenth on Valve-Gear; the fourteenth on the Effect of the Reciprocating Parts; the fifteenth to the twentieth contain descriptions of different types of Compound Locomotives; the twenty-first is on Starting Gear; the twenty-second on Reasons for Economy, and the twenty-third on Different Types of Compound Locomotives. An appendix contains a variety of data for which no appropriate place could be found in the body of the book. A good index completes the volume, which is well printed, on fairly good paper, and is illustrated with engravings made by a photo-engraving process, which are very good of their kind.

Altogether the book is the best treatise on the subject in existence, but in view of the tentative character of its subject we are inclined to think that a treatise of this kind should have the form of an annual, which each year would summarize the failures and report the successes of compound locomotives. Such a series of books would become a sort of history of the mechanical evolution of compound locomotives, which might be as useful to future investigators as Bulwer's proposed history of human error.

ALBUM AND CATALOGUE *of the Société Suisse Pour la Construction de Locomotives et de Machines.* Winterthur, Suisse. 34 plates and text. 13½ × 9¾ in.

We have received a copy of a new album and catalogue just issued by this Company, which is interesting if compared with the catalogues of locomotive builders in this country, first as an example of this class of publications, and, second, as illustrating the types of locomotives constructed at these works. The plates consist of half-tone engravings printed on heavy plate paper with a somewhat rough surface, and of a different texture from any we remember seeing used in this country. The effect is very good, and is improved by a light buff background, on which the plates are printed. The descriptions and dimensions of the engines illustrated are given on thin sheets opposite the engraving, and are given in French and German.

The first engine illustrated is a small four-wheeled coupled tank engine, which has the walking-beam arrangement designed by Mr. Brown, the former Superintendent of these works. The next plate illustrates an engine of the "type Forney," which resembles closely the locomotives used on the New York Elevated roads. The third is a four-wheeled tank engine with outside cylinders in the usual position. The valve-gear is an Allen straight link worked from overhung cranks on the outside of the back crank-pins. The fourth plate shows a similar machine to its predecessor, but with an outside Walschaert valve-gear. This form of valve-gear is used on perhaps one-half of the engines illustrated. There are several examples of locomotives of the mogul type, some with tenders and others without, the latter having the tanks between the frames and on the sides of the boiler. A peculiarity of some of this class of engines is that the cylinders are placed behind the smoke-box. In the side view of these engines the center of the chimney is about coincident with a vertical center line drawn through the center of the truck. The back axles appear to be behind the fire boxes or immediately below the back portion. This arrangement makes a very compact-looking engine with quite long tubes. In some of them the steam-pipes are carried outside of the boilers, which would not commend itself to American builders. Fig. 11 shows a very neat design and follows American practice very closely. The driving-wheels are about 4 ft. diameter. The foot-board is placed within a few inches of the top of these wheels, and that of the tender and the running-board are all placed on the same line. Consequently the top surfaces of all of these are in a continuous horizontal line, from the back part of the tender to the front of the engine. It gives the engine a very simple appearance, and the method of construction does not seem to be in any way objectionable.

A number of small tramway locomotives, with four and six wheels coupled, are also illustrated; most of them have Brown's walking beam with the cylinder horizontal and elevated above the driving-wheels. This establishment has made a specialty of locomotives for steep mountain roads, which are operated with toothed racks and gears, and a number of such engines are illustrated in the catalogue before us. Some of them appear to be very complicated. There are a great many ingenious features illustrated in the designs in this book, which would require much more space than we can now give to them to describe, and any one who has ever designed a locomotive will be very much interested in studying the ingenious devices which are shown, and for which this establishment has always been noted.

I. The Oriental Republic of Uruguay at the World's Columbian Exhibition, Chicago, 1893. *Geography, Rural Industries, Commerce, General Statistics.* By Carlos Maria de Pena and Honore Roustan, Director of the General Statistics Office. Translated into English by J. J. Rethore. Montevideo, 1893. 54 pp., 6¾ × 10 in., and folded map.

II. Treatise on the South American Railways and the Great International Lines; *sent to the World's Exhibition of Chicago by the Ministry of Foment (?) of the Oriental Republic of Uruguay.* Montevideo: La Nación Steam Printing Office, Calle 25 de Mayo, Nos. 146–54, 1893. 1,252 pp., 11 × 7½ in.

III. Comparison of English and American Locomotives in the Argentine Republic. 16 pp., 10½ × 5 in.

The title-pages of these books, which have been transcribed above, will give an idea of their character. The first is a pamphlet prepared for distribution at the Chicago Exhibition, and intended to give an idea of the resources and general characteristics of the Republic of Uruguay.

The second, as its name implies, is a treatise on the South American Railways, and embraces the railways in the Republic of Uruguay, the Argentine Republic, the United—or must we now say the Disunited?—States of Brazil, the Republics of Chile, Paraguay, Bolivia, and Peru, the Intercontinental and Interoceanic lines, the Population of the South American States, and a description of the Ports and Railways of the Oriental Republic. The first part of the book is an English translation of the Spanish text, which is given in the latter half. A map of the South American Railway was intended to accompany the volume, but this unfortunately has not reached us.

The third publication is a pamphlet, from which we give some extracts on another page.

Journal of the American Society of Naval Engineers. *Volume V, No. 4, November,* 1893. Published quarterly by the Society, Washington, D. C.

This publication comes to us with a long list of interesting papers, articles, and notes which swell its dimensions to 314 pp. Only a small number of these papers were, however, prepared especially for this publication or for the Society which it represents. The question might be raised as to how far it is judicious for a Society like this to distend its published proceedings with reprints which are easily accessible in other publications. If a Society can make original contributions to the knowledge for the promotion of which it is organized, whatever it can give will be received with open hands and, it may be said, open minds. If it becomes a dealer in second-hand articles it may serve some useful purpose, but can hardly assume a first place among the institutions of learning.

Per I Mercati Coperti (On Covered Markets). By Marc Aurelio Boldi. Published by the Fratelli Centenari, Rome. 7½ × 9 in., 140 pp., paper covers.

In this book Signor Boldi treats the subject of covered markets in all its branches, not only their materials, construction, and architecture are fully considered, but all the laws and regulations in every detail which should govern the administration of the traffic carried on in them. The work is divided into five parts. The first opens with a brief historical account of the rise and development of markets in various countries; next are presented the conditions which should be fulfilled by covered markets to-day, in order to produce the highest degree of usefulness. In the second part, to show what has been done to provide the centers of habitation with covered markets satisfying such conditions, a description is given of many markets erected in Europe in the nineteenth century, followed by a table containing the principal data relating to such markets. In the third part is described, with still greater minuteness, what has been done in Italy. No mention is made of any American markets. France, it is stated, has always taken the lead in these matters, and with regard to the excellence of its covered markets holds indisputably the first place among civilized nations. The Author states that in these descriptions his aim is not so much to make an abstract study of covered markets as to collect all the information possible, especially of a technical nature, which can be of use to those particularly interested in the subject. In parts fourth and fifth are given the results of Signor Boldi's studies. He here presents his views as to the means he considers most conducive to the end of perfection of building and arrangement in every respect. He closes with some remarks on markets as financial investments he had hoped, he says, at the time of beginning the book, to be able to give figures upon which arguments in their favor must be based, but that statistics do not yet furnish such information in a way to serve this end. He has, however, in the course of his own studies and investigations, arrived at the conclusion that covered markets should be classed among those building enterprises which yield a high rate of interest, his opinion being that such interest fluctuates in the neighborhood of 7 per cent. The book is clearly and concisely written. Eight folding plates give views and plans of ancient and modern markets.

BOOKS RECEIVED.

Proceedings of the Twenty-fourth Annual Convention of the Master Car and Locomotive Painters' Association of the United States and Canada, held at Milwaukee, Wis., September 13–15, 1893. 54 pp., 10 × 6¾ in.

Annual Report of the State Geologist of the State of New Jersey, with two large maps, one of the State of New Jersey and the other of parts of Monmouth and Middlesex counties. 367 pp., 9 × 5¾ in. Trenton, N. J.: The John L. Murphy Publishing Company, Printers.

TRADE CATALOGUES.

The number of Trade Catalogues which are sent to us during the past month is so great that we find it impossible to do more than to make a very brief mention of them:

Standard Water-Tube Safety Boilers, manufactured by The Link Belt Machinery Company, Chicago. 8 pp.,

$5\frac{3}{4} \times 7\frac{1}{2}$ in. Describes the construction of the boilers briefly, and illustrates them with a perspective sectional view and engravings of boiler fronts. Also gives illustration and description of the Ewart clutch and view of works on last page.

THE CASWELL HOT-WATER CIRCULATOR, for Heating Dwellings, Stores, Greenhouses, Depots, Schoolhouses, etc., with Hot Water by Forced Circulation, manufactured by F. K. Caswell & Co., Hartford, Conn. 8 pp., $5\frac{3}{4} \times 8\frac{1}{4}$ in. The circulator is illustrated and described, and its application to a heater shown.

THE ROBINS LIFE GUARD OR SAFETY FENDER FOR ELECTRIC AND CABLE CARS. By the Robins Life Guard and Manufacturing Company, Philadelphia. 14 pp., $6 \times 9\frac{1}{4}$ in. Illustrated by engravings of the apparatus, some of which show more or less dilapidated individuals in precarious positions on the fender. An improvement in the moral appearance of the persons who are saved would add to the apparent merits of the device. Those shown in the engravings look like tramps, and it is a little questionable whether it might not be as well to run over some of them. A device, however, which will catch tramps will also save honest folks, and that is what this "life guard" is intended for.

NEW UNIVERSAL CUTTER AND TOOL GRINDER. By the Cincinnati Milling Machine Company, Cincinnati, O. 24 pp., $6 \times 9\frac{1}{4}$ in. This publication gives first a good engraving of the machine, the construction of which is afterward described. On the fourth page an engraving, made from a photograph, is given which shows various kinds of cutters, reamers, and other tools which may be ground on the machine. On pp. 6 to 15 inclusive a number of outline engravings are shown, indicating the method of using this machine, with clear descriptions explaining how it is done. Some suggestions with reference to the care and use of the machine and a list of parts, which may be furnished, completes the pamphlet.

THE 2×24 FLAT TURRET LATHE, manufactured by the Jones & Lamson Machine Company, Springfield, Vt. 71 pp., 6×9 in. This volume contains two very good engravings showing front and back views of the machine described, and descriptions thereof. These are followed by six pages of engravings showing the chucks, slides, tools, and various appliances which are used. Twelve pages of illustrations showing and describing the kind of work which can be done on this machine. A chapter with six engravings showing and describing its evolution and a full description of it follow. Facsimiles of testimonial letters, a list of users, directions for setting up and operating the machine, and a folded plate showing some large specimens of work done on it, with a table of speeds on the back, complete the publication.

THE VENTURI METER, [illegible] by Clemens Herschel, Hydraulic Engineer, made by Builders' Iron Foundry, Founders and Machinists, Providence, R. I., $5\frac{3}{4} \times 9$ in. This pamphlet is unpaged, but contains about 70 pp. It contains first a description of the Venturi meter, of which it is said in the opening paragraph that "it is named for the Italian philosopher, Venturi, who first called attention, in 1796, to the relation between the velocities and pressures of fluids when flowing through converging and diverging tubes." The description of the instrument is followed by a reprint of a paper describing it, which was read before the Society of Civil Engineers in 1887. Following this is an extract from Mansfield Merriman's Hydraulics on the same subject. The conclusion consists of tables giving the performance of the meter and tests of its accuracy. The book has numerous illustrations, is well printed, and in excellent taste all through.

THE WIDENING USE OF COMPRESSED AIR. By Whitfield Price Pressinger. 7 pp., $5\frac{3}{4} \times 9$ in. This is a reprint of an article which appeared originally in the *Engineering Magazine*. The uses to which compressed air is put are briefly described, such as for pneumatic dynamite guns, block signaling, raising water, in the use of crude petroleum for fuel, in emptying tanks ; in india-rubber factories the hose is removed from the iron mandrels by forcing a current of air under 50 or 60 lbs. pressure between the hose and mandrels, thereby inflating the hose and permitting it to be easily slipped off ; for pneumatic riveting machines, cranes, and hoisting machinery, for pneumatic tubes for transmitting mail matter and other parcels, refrigeration and ventilation, the propulsion of cars, for conveying coal culm, the disposal of sewage, for painting buildings, for sheep shearing machines, raising vessels, purifying water, and for steering-gear for vessels.

THE WESTINGHOUSE SINGLE-ACTING ENGINES, COMPOUND, STANDARD, AND JUNIOR. Designed and built by the Westinghouse Machine Company, Pittsburgh, Pa. 109 pp., 7×9 in. This is one of the most luxurious catalogues that has come to us for a long time. The cover, printed in a raised and very artistic design, with a buff and brown ground, is a work of art. The engraving, the paper, the printing, the ink, of a bronze color, is all of the most luxurious kind. There is first a general view of the works, followed with a chapter which tells why the Company builds the kind of engines they do, and gives a perspective view of the engine exhibited at Chicago. Very elaborate perspective and sectional engravings follow, with full descriptions of the different classes and their details, advantages, principles, and theory of their construction, their operation, and economy, and a general description of the character and extent of the business. Our brief notice does scant justice to the merits of this volume—which is from the press of Bartlett & Co., of New York—but it occupies all the space that is available.

THE LOCOMOTIVE PROBLEM.

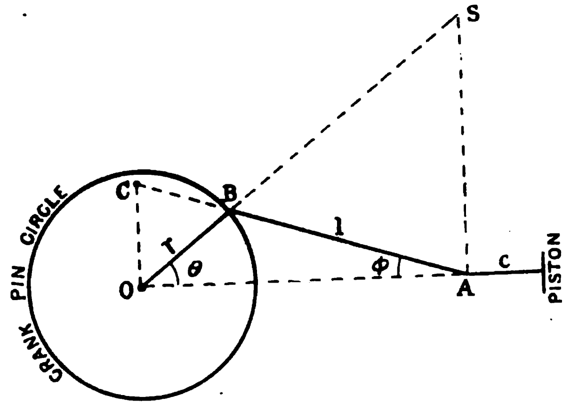
BY RENÉ DE SAUSSURE, C.E., ROANOKE, VA.

IN reading over the last April number of THE AMERICAN ENGINEER, I noticed an article entitled The Locomotive Problem, by C. H. Lindenberger, C.E., Detroit, Mich., which contains evidently a wrong solution of the problem.

Mr. Lindenberger announces this problem as follows :

"Let it be supposed that the stroke of the pistons of a locomotive is 2 ft., the diameter of the driving-wheels 8 ft. and the velocity 60 miles per hour : what is the maximum and minimum velocity of the piston relatively to the earth and not with regard to the locomotive, and when does each occur ?"

The author has chosen the usual analytical method for finding maxima and minima—*i.e.*, by writing that the differential of the velocity $= 0$ for a maximum or minimum ; this he has the right to do, although this method is much more complicated in this case than the geometrical solution ; but the mistake begins in solving the equation of third degree resulting from this analytical method. The detail of this last calculation is not published in the article above mentioned ; and my opinion is that the formula adopted to solve the equation of third degree must have been only a formula of approximation, for Mr. Lindenberger concludes by saying :



"So that the maximum and minimum velocity is not for these parts [the crank-pin radius and the connecting-rod] at right angles, *as some solutions assume*, but is very near that place."

Now, I would ask the author whether he has examined those solutions that "assume," or, rather, whether he thinks that a mathematical demonstration "proves beyond any doubt" or just "assumes." To decide this question, I will take the liberty of recalling here in a few words the usual geometrical solution of this problem :

Let $A B$ be the connecting-rod.

Let $O B$ be the crank-pin radius.

Let $u =$ the velocity of the piston.

Let $\omega =$ the angular velocity of the crank-pin radius, or the angle described by this radius in the unit of time. This angular velocity is constant, since the velocity of the engine is supposed to be constant.

First, it is evident that the maximum and minimum velocities of the piston relatively to the earth occur at the same time as the maximum velocities of the piston relatively to the locomotive; the constant velocity of the engine having only for effect to change one of these maxima into a minimum, when the piston moves backward; so that it is only necessary to find the positions for which the velocity of the piston is maximum relatively to the locomotive.

Second, the point A having the same motion as the piston, will have a maximum velocity at the same time as the piston; we can therefore apply the reasonments to point A instead of the piston. We have now done away with two constants—*i.e.*, the velocity V of the engine and the distance c from point A to the piston. The uselessness of these two constants appears distinctly in the analytical method of Mr. Lindenberger, as they have both disappeared from his equations by the time he has taken the second differential, thus showing that the result is independent of V and c.

Now, supposing that at the start the piston and connecting-rod have the position shown in the figure, let us examine what occurs when the piston moves during a time infinitely short, $d\,t$. The point A moves in the direction $O\,A$ and describes a length $= u\,d\,t$; if we draw $A\,S$ perpendicular to $O\,A$, this length, $u\,d\,t$, being infinitely small and being at right angle with $A\,S$, can be considered as a very short arc of circle described with any radius provided the center is chosen somewhere on the line $A\,S$.

In the mean time, point B has moved on the crank-pin circle. But the length of the motion of B being also infinitely small, and the straight line $O\,B$ being perpendicular to the crank-pin circle, the element described by point B can be considered as a very short arc of circle of any radius provided the center is chosen somewhere on the line $O\,B$.

Now point A and point B are connected together by a solid rod; we know, further, that point A rotates during the time $d\,t$ around any point of $A\,S$, and that point B during the same time rotates around any point of $O\,B$, so that the straight line $A\,B$ rotates around the point common to $A\,S$ and $O\,B$, or around point S. In other words: During the time $d\,t$, the motion of the connecting rod $A\,B$ can be considered as a rotation infinitely small of said rod around point S.

The element described by point B on the crank-pin circle during the time $d\,t$ has a length equal to $\omega\,r\,d\,t$; dividing the length of this element by the radius $B\,S$ we obtain $\frac{\omega\,r\,d\,t}{B\,S}$ for the expression of the size of the angle described by point B around point S. But the point A also turns around S of the same angle, as we have proved that during the time $d\,t$ the whole connecting-rod rotates around point S. Therefore the point A describes an element equal to this angle multiplied by the distance of A to S, or, $\frac{\omega\,r\,d\,t}{B\,S} \times \overline{A\,S}$.

On the other hand, we have seen that point A describes in the direction $O\,A$ an element $= u\,d\,t$; as point A can have but one motion, these two elements are equal; therefore,

$$u\,d\,t = \frac{\omega\,r\,d\,t}{B\,S} \cdot \overline{A\,S},$$

or,

$$u = \omega\,r\frac{\overline{A\,S}}{\overline{B\,S}}.$$

If we draw $O\,C$, or a vertical line, through center, O, until it meets the direction $A\,B$, we have in the two similar triangles $O\,B\,C$ and $A\,B\,S$ the proportion

$$\frac{A\,S}{B\,S} = \frac{O\,C}{r};$$

replacing in the above equation, we have finally,

$$u = \omega \times \overline{O\,C},$$

and ω being constant, this shows that the velocity u of the piston is proportional to the theoretical line $O\,C$, therefore the maximum of u will correspond to the maximum of $\overline{O\,C}$.

After each element of time, $d\,t$, the position of points S and C changes; but it is easy to see that $\overline{O\,C}$ will be maximum when $A\,B$ becomes tangent to the crank-pin circle, or when the crank-pin radius is at right angle with the connecting-rod.

This is not an approximate solution; it means either that the maximum speed of the piston is attained when the connecting-rod is exactly perpendicular to the crank-pin radius, or that the whole cinematical geometry is based upon wrong principles.

Without following all the calculations of Mr. Lindenberger, we can show the same result on his own equation. Keeping the same figures as those used in his demonstration, he obtains the following expression for the velocity of the piston:

$$V + v\frac{\sin.(\theta + \phi)}{\cos.\phi},$$

and he admits himself that V and v being constant, the maximum of this velocity will be reached when the coefficient $\frac{\sin.(\theta + \phi)}{\cos.\phi}$ is itself maximum. Now, when the connecting-rod is perpendicular to the crank-pin radius or tangent to the crank-pin circle, $\theta + \phi = 90°$ or $\sin.(\theta + \phi) = 1$, which is the maximum value for any sinus. Besides the angle ϕ in this position has attained its maximum value, therefore $\cos.\phi$ has reached its minimum value. The numerator $\sin.(\theta + \phi)$ being maximum, and the denominator $\cos.\phi$ being minimum, their quotient is surely a maximum.

In the numerical example mentioned by Mr. Lindenberger, he finds that this quotient equals 1.0540926, when the connecting-rod is at right angle with the crank-pin radius, and that for a certain position very near it this same coefficient has a larger value—1.05464; these two values are so near each other that the error must be attributed to the small errors committed in extracting square roots or in using the trigonometrical tables.

AMERICAN AND ENGLISH LOCOMOTIVES.

(*Continued from page 563, Volume XLVII.*)

Specification of English Express Passenger Locomotive.

LONDON & SOUTHWESTERN RAILWAY.

Tender for Four-Wheels Coupled Bogie Passenger Engines and Tenders.

To the London & Southwestern Railway Company:

Gentlemen: We undertake to build —— bogie passenger engines and tenders and to deliver the same, carriage free, at your Nine Elms Works, London, in strict accordance with your specifications and drawings, and subject to the general conditions hereto annexed, for the sum of £———— for each engine and tender, and to execute a formal contract for the whole of the above or any less number which you may assign to us, if and when called upon by you to do so.

The deliveries to be not less than —— in eight months from the date of order and at the rate of —— per month afterward.

Contractor's Signature.............................

" Address.............................

Date.............................

LONDON & SOUTHWESTERN RAILWAY COMPANY.

Specification of Four-Wheels Coupled Bogie Passenger Engine.

DRAWING NO. 6,815.

Principal Dimensions.

	Ft.	In.
Inside diameter of cylinders	1	7
Stroke of piston	2	2
Length of boiler barrel between plates	11	0
Diameter " " outside	4	4
Length of fire-box shell outside	6	4
Width " " at bottom	3	10¼
Number of tubes	240	
Diameter " outside	0	1¾
Height of center of boiler from rails	7	9
Length of engine frame	30	4
Thickness " "	0	1
Distance between "	3	11½
Diameter of bogie wheels on tread	3	9¾
" driving " " } coupled	7	1
" trailing " " } coupled		
Center of bogie to center of driving-wheels	10	9
" driving " trailing "	8	6
" bogie-wheels	7	6

Wheel base from center of leading bogie to center of trailing-wheels	23	0
Height of center of buffers from rails	3	6
Working steam pressure	175 lbs. per square inch.	

PRELIMINARY REMARKS.

Where the dimensions are omitted in this specification they will be found fully detailed in the drawings, and these, as well as the terms of this specification, must be strictly adhered to, except in cases where the consent in writing of the Railway Company's Locomotive Superintendent has been first obtained.

IRON.

In all cases where the words "Best Yorkshire Iron" are specified, the same must be wrought iron of the manufacture of Lowmoor, Bowling, Coopers, Taylor's, Monkbridge, or Farnley best iron. In all cases the brand of the manufacturer is to be kept where it can be seen.

BRASS.

The brass, where specified, must be of good tough metal.

GUN-METAL.

The gun-metal used must be composed of copper 8 parts, tin 1 part.

WHITE METAL.

The white metal must be composed of Dewrance's anti-friction metal.

BOILER PLATES.

The barrel, smoke-box tube plate, fire-box casing and throat and back plates of fire-box, also all dome plates and butt strips to be made of the best mild steel of the exact dimensions, both as regards form and thickness, as given on the drawings. To be supplied by makers approved by the Railway Company's Locomotive Superintendent.

Quality—The quality of the material to be that generally known as mild steel plate, and to be free from silicon, sulphur, or phosphorus. The ultimate tensile strain that the plates will stand to be not less than 25 nor more than 30 tons per square inch, and to have an extension of not less than 23 per cent. in 10 in.

Manufacture.—All plates to be made in the most approved manner from ingots hammered on all sides, and, when re-heated, to be rolled truly to a uniform thickness. Both sides to be perfectly clean and free from pitting, roll marks, scale, dirt, overlapping, or other defects. Each plate to be taken from the rolls at a full red heat, and allowed to cool gradually on a flat surface. Each plate is to be sheared to the dimensions given, and in no case to be sent out before being leveled sufficiently true for machining. All plates that are wavy or buckled, or in any way defective, will be rejected, and must be replaced by the makers, free of cost. The maker's name and date of manufacture must be legibly stamped on every plate, and not nearer the edges than 9 in.

A sample or test plate at least 2 ft. square must be sent in by the maker as a sample of what will be supplied in the plates to be made under this contract, together with a complete analysis of the same. This test plate is to be ½ in. in thickness, and from it pieces will be taken for proving in the following manner:

Test.—A piece 6 in. long will be bent over cold until the ends meet each other closely, and no fracture or sign of failure is to be observable in the heel of the bend. Pieces 3 in. wide will also be taken and a ¾-in. hole punched through same, which shall stand being drifted cold by taper drifts until it reaches 1¼ in. in diameter without the edges fraying or showing signs of fracture.

Samples or shearings from the plates must be tested in the presence of the Railway Company's Locomotive Superintendent or his Inspector, on the premises of the maker, whenever desired.

The barrel and fire-box casing plates to be thoroughly annealed *after* the rivet holes are punched.

The smoke-box tube-plate, throat and back plates of the fire-box to be thoroughly annealed after they have been both flanged and punched.

BOILER BARREL.

The boiler barrel is to be cylindrical and butt-jointed, and is to be made in all respects as shown on drawings; it is to be 11 ft. long between the smoke-box tube-plate and the throat-plate of the fire-box shell, 4 ft. 4 in. outside diameter, and composed of ½ in. plates. The longitudinal joints are to have inner and outer covering strips double riveted, the rivets being placed zigzag. The transverse joint to have an exterior steel weldless ring double riveted. Ring to be turned inside to gauge and to the exact diameter necessary, and then shrunk on. All studs and fittings are to be fixed before the boiler is tested.

SMOKE-BOX TUBE-PLATE.

The smoke-box tube-plate is to be ¾ in. thick, the tops and sides of the plate being turned forward 2¾ in., forming a flange for the smoke-box, and is to be secured to the boiler barrel by a continuous weldless ring of angle steel well annealed, and supplied by makers to be approved by the Railway Company's Locomotive Superintendent. The ring must be faced, bored and turned on the edges, and then shrunk on the boiler barrel, and is to be double riveted to the same, the rivets being placed zigzag. The tube-plate is to be faced where it is joined to the boiler steel angle. Eight wash-out plugs are to be inserted in the plate, as shown on drawing.

FIRE-BOX CASING.

The fire-box casing is to be 6 ft. 4 in. long and 3 ft. 10½ in. wide outside at the bottom, and to be 5 ft. below the center line of the boiler. The top and sides are to be in one plate ½ in. thick. The back plate to be 9/16 in. thick, and flanged over to join the covering plate. The front or throat plate is to be 9/16 in. thick, and flanged over to join the barrel.

All riveted joints in fire box casing to be double riveted. The expansion brackets are to be riveted to the sides of the fire-box shell. The holes in fire-box casing plates for copper stays are to be drilled and then tapped to form a good thread.

RIVETING.

All rivet holes to be punched or drilled ⅞ in. in diameter, all rivets to be of the best Yorkshire iron with a breaking strength of not less than 22 tons per square inch, and an extension of not less than 30 per cent. in 2 in. Rivets to be 13/16 in in diameter before being closed, and to be closed wherever possible by a hydraulic pressure of at least 30 tons, so that they properly fill the rivet holes. The holes in the plates are to be slightly countersunk under the rivet heads, and so punched that when the plates are in the proper position for riveting the smaller dimensions of the holes shall be together at the center of the joint. All holes in the various plates and angle-irons must be perfectly fair with one another, and must not be drifted in any case; should any of the holes not be perfectly fair they must be rimered out until they become so, and every hole must be completely filled by the rivet. The holes in the angle-irons must be marked from the plates and drilled (not punched), the pitch of rivets and lap of joints being in all cases as shown on drawing. Great care must be taken that the plates are brought well together before any rivets are put in. The edges of all the plates are to be planed before being put together. Any caulking which may be required must be done with a broad-faced tool, care being taken that the plates are not injured by so doing.

COPPER FIRE-BOX PLATES.

The copper plates to be of the very best quality manufactured, and to be supplied by makers approved by the Railway Company's Locomotive Superintendent, of the exact dimensions, both as regards form and thickness, as given on the drawings.

The copper plates are to be properly annealed, and a piece taken from each plate must stand the following tests—viz.:

The ultimate tensile strain to be not less than 13.5 tons per square inch, with an elongation of not less than 40 per cent. in 2 in.

A piece 6 in. long is also to be bent double when cold, without showing signs of fracture at the heel of the bend.

Tests to be made in the presence of the Locomotive Superintendent of the Company or his Inspector.

INSIDE FIRE-BOX.

The inside fire-box is to be of copper, 5 ft. 5 3/16 in. long inside at the top, and 5 ft. 7⅞ in. long inside at the bottom; the height inside at the middle of the box is to be 5 ft. 9½ in., the width inside at the top, 3 ft. 6 in., and at the bottom, 3 ft. 2½ in. The tube-plate is to be 1 in. thick where the tubes and barrel-stays pass through it; the remaining portion is to be reduced by hammering to ½ in. thick, and is to be flanged back to join the covering plate. The back-plate, which must be ½ in. thick, is to be flanged forward. The sides and top are to be in one plate and ½ in. thick; the joints are to have 2½ in. lap when finished, and to be single riveted with ¾-in. iron rivets, same quality as used for boiler. All the joints in the copper fire-box are to be hand riveted. Two fusible plugs are to be fixed in the crown of the fire-box.

FIRE-HOLE DOOR.

The ring for the fire-door is to be of the best Yorkshire iron, and is to be circular and of the dimensions shown on drawing. The ring is to be riveted to the fire-box by ¾ in. rivets, and is to project ⅛ in. beyond the edges of the plates, which must be well caulked. The fire-door is to be of cast iron, formed in two halves, and made to slide as shown on drawing. A wrought-iron deflecting plate is to be fixed in the fire-door hole as shown. Also a brick arch in the fire-box as shown.

STAYS.

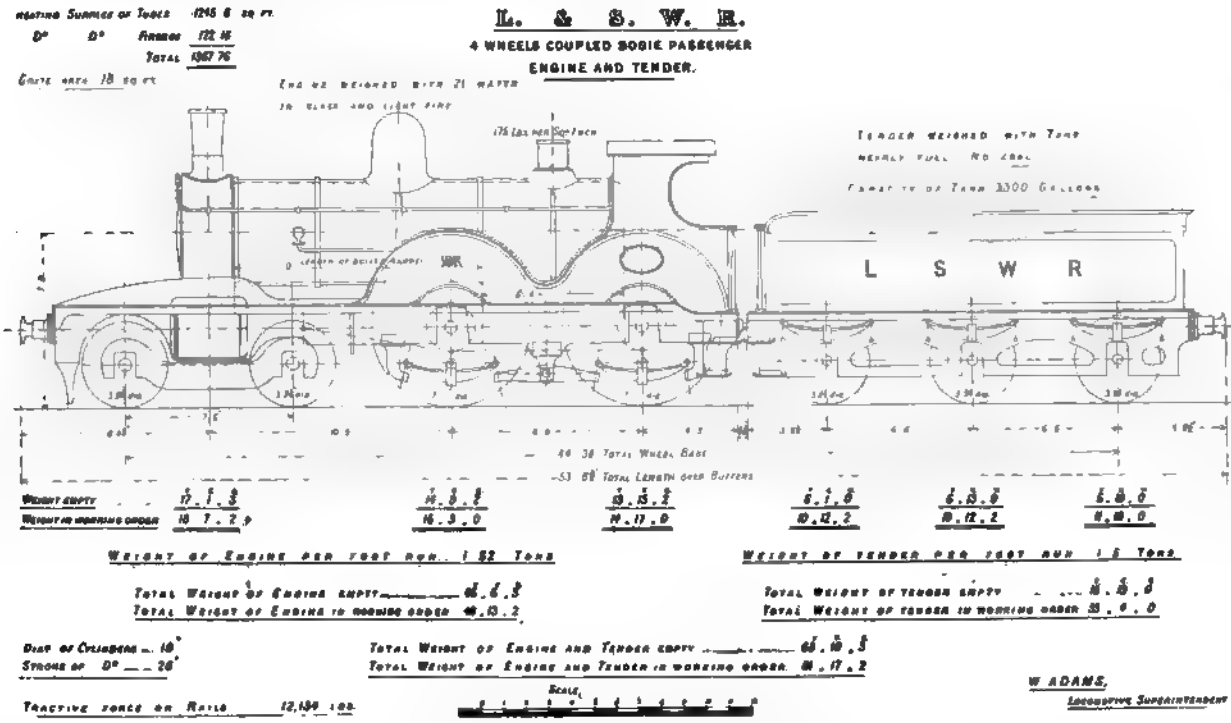
The outside and inside fire boxes are to be stayed together on all sides with copper stays 1 in. in diameter and 12 threads per inch, made from best soft rolled bars, having a breaking strength of not less than 14 tons per square inch, with an extension of not less than 40 per cent. in 2 in. properly annealed, screwed steam tight into both copper and steel plates, and afterward riveted over. Great care must be taken in cutting off the ends of the stays so as not to injure the threads. The pitch of the copper stays to be about 3¼ in., center to center, as shown. Great care must be taken that the holes in the outside and inside boxes are exactly opposite one another. The barrel stays are to be riveted to the boiler with ¾-in. rivets and spelter. The tubes are to be inspected by the Railway Company's Locomotive Superintendent or his Inspector, and supplied clean, and are not to be covered with paint or any similar coating. The maker's name to be clearly stamped on the outside of each tube. The tubes are to be expanded by a Dudgeon's tube expander, and ferruled at the fire-box end only. At the smoke box end the tubes are to stand through the plate ½ in.

DOME.

The steam dome is to be made as shown on drawing, and to be provided with steel cover. The dome is to be 2 ft. 0 in. inside diameter, and 2 ft. 2 in. high inside, and ½ in. thick. The dome is to be made in one plate and butt jointed as shown. A strengthening plate ½ in. thick is to be riveted to the inside of the boiler under the dome as shown on drawing. The hole for the dome is to be 19¼ in. in diameter. A soft steel manhole seating is to be single riveted to the center of the fire-box top, and fitted with a cast-iron cover plate formed in one with the safety-valve columns. The cover-plate and manhole seating are to be accurately faced, so that a perfect steam-tight joint can be made.

REGULATOR.

In the inside of the dome is to be placed a cast-iron regu-



lator in two parts, with flanged joint, to have two valves, main valve of brass and the easing valve of cast iron, to be worked from the back of the fire-box. The steam-pipe leading from the regulator to the smoke-box is to be of hard-drawn copper, No. 6 Standard W. G., 5¼ in. inside diameter, and is to have a brass flange brazed on where it fits into the tube-plate; the other end of the pipe to have a brass collar brazed on, and is to be secured to the stand regulator pipe as shown.

secured to the tube-plate as shown on drawing. The inner copper fire-box is to have eight roof stay-bars of cast steel of approved make of the section shown, and secured to it by bolts which are tapped into the stays only as shown on drawing. The stays are to bear on the top, back and front plates, and are to be slung where shown to the outer shell. The back plate of the fire-box casing and the smoke-box tube-plate are to be stayed together with 11 wrought-iron longitudinal stays 1⅛ in. in diameter where they pass through the back plate, and 1½ in. in diameter for the remainder of their length; these stays are to have the head bedding on a copper washer and screwed into the fire-box plate; at the other end they are to be secured by a nut bedding on a copper washer on each side of the plate.

TUBES.

The boiler is to contain 240 brass tubes, of a brand and manufacture to be approved by the Railway Company's Locomotive Superintendent. Each tube is to be 1¾ in. outside diameter expanded at smoke-box end to 1⅞ in. outside diameter for a length of 8 in. and contracted to 1⅝ in. outside diameter at fire-box end. Each tube is to be No. 11 Standard W. G. thick at the fire-box end for a length of 1 ft. and then to be drawn tapered to No. 13 Standard W. G. thick at the smoke-box end, the taper being on the inside only, the outside remaining parallel. The proportion for the metal in the tubes to be 70 per cent. best selected copper, and 30 per cent. best Silesian

WATER SPACE.

The water space between the fire-box and shell is to be 3 in. wide at the foundation ring, and is to be enlarged upward to the dimensions shown on drawing.

FOUNDATION RING.

The foundation ring is to be of best Yorkshire iron, 3 in. wide × 2¼ in. deep, and riveted to the inside and outside fire-boxes with ¾-in. rivets, snap-headed, 2-in. pitch, to the section as shown on drawing.

ASH-PAN.

The ash-pan is to be placed below the fire-box casing, with movable doors and perforated dampers at the back and front, so arranged as to be worked from the back of the fire-box.

The handles for working the doors are to be placed at a convenient height on the foot-plate as shown. The sides are to be of ½-in. plates, and the bottom of ½-in. plate, of Best Best Staffordshire iron ; angle-irons 2 in. × 2 in. × $\frac{5}{16}$ in. thick, are to be riveted to the sides and bottom with ½-in. rivets. The ash-pan is to be of the form, and fixed in the manner shown, by angle-irons 4 in. × 3 in. × ½ in., and cottared pins screwed into foundation ring.

FIRE-BARS AND CARRIERS.

The fire-bars are to be of cast-iron, of the form and dimensions shown, and the carriers of wrought iron secured to the foundation ring in the manner shown on drawing.

SMOKE-BOX.

The smoke-box is to be of the form and dimensions shown on drawing. The sides and crown are to be $\frac{5}{16}$ in. thick, riveted to the flange of the smoke-box tube-plate. The front-plate is to be in one, and ⅜ in. thick. An angle-iron 2½ in. × 2½ in. × ½ in. thick is to be riveted to the front and side-plates. A hole for the door is to be cut in the front-plate 3 ft. 10 in. in diameter. The door is to be of Best Best Staffordshire iron ⅜ in. thick, protected on the inside with a shield, placed 1⅜ in. from door. Great care must be taken that the door when closed is made a perfectly air-tight joint. The cross-bar is to be made to lift out of forged brackets, which are to be riveted to the inside of the front of the smoke-box. Two handles and a gripping screw are to be provided. All the plates are to be clean and smooth and well ground over. All rivets are to be ⅝ in. in diameter, pitched as shown on drawing, and are to be countersunk and filed off flush. The outside handles are to be finished bright. All lamp-iron brackets are to be fixed as shown.

CHIMNEY.

The barrel of the chimney is to be of good smooth Best Best Staffordshire iron ¼ in. thick, to have a butt joint, and is to be riveted together with countersunk rivets down the back, having a hoop of half-round iron at the top ; the bottom is to be of best Yorkshire iron or mild-steel plates ⅜ in. thick, perfectly free from hammer marks, and accurately fitted to the smoke-box. The height of the top of the chimney from rails is to be 13 ft. 2⅜ in.

FRAMES AND AXLE-BOX GUIDES.

The frames and frame stay-plates to be made of the best mild Bessemer or Siemens-Martin steel, supplied by makers approved by the Railway Company's Locomotive Superintendent, and of the exact dimensions, both as regards form and thickness, as given on the drawings.

Quality.—The quality of the material to be that generally known as mild-steel plate, and to be free from silicon, sulphur, or phosphorus. The ultimate tensile strain that the plates will stand to be not less than 24 nor more than 30 tons per square inch, with an extension of not less than 23 per cent. in 10 in.

Manufacture.—All plates, whether made by the Bessemer or Siemens-Martin process, to be made in the most approved manner from ingots hammered on all sides, and when reheated, to be rolled truly to a uniform thickness. Both sides to be perfectly clean and free from pitting, roll marks, scale, dirt, overlapping, or other defects. Each plate to be taken from the rolls at a full red heat, and allowed to cool gradually on a flat surface. Each plate is to be sheared to the dimensions given, and in no case to be sent out before being leveled sufficiently true for machining. All plates that are wavy or buckled or in any way defective will be rejected, and must be replaced by the makers, free of cost. The maker's name and date of manufacture must be legibly stamped on every plate, and not nearer the edges than 9 in.

A sample or test plate at least 2 ft. square must be sent in by the maker as a sample of what will be supplied in the plates to be made under this contract, together with a complete analysis of the same. This test plate is to be ½ in. in thickness, and from it pieces will be taken for proving in the following manner :

Test.—A piece 6 in. long will be bent over cold until the ends meet each other closely, and no fracture or sign of failure is to be observable in the heel of the bend. Pieces 3 in. wide will also be taken and a ⅝-in. hole punched through same, which shall stand being drifted cold by taper drifts until it reaches 1½ in. in diameter without the edges fraying or showing signs of fracture.

Samples or shearings from the plates must be tested in the presence of the Railway Company's Locomotive Superintendent or his Inspector, on the premises of the maker whenever desired.

All the plates are to be perfectly level and straight throughout, and marked from one template. All holes are to be drilled and rimered out to the exact sizes given, and each bolt and rivet must be turned to gauge, and fitted into its place, a good driving fit. When the frames and cylinders are bolted together, and before the boiler, wheels and axles are put in their places, the accuracy of the work must be tested by diagonal, transverse and longitudinal measurement.

The frames are to be placed at a distance of 3 ft. 11½ in. apart, and to be stayed at the leading end, in front of the driving-wheels, and in front of the fire-box by steel plates and angle-irons, and by a cast-iron foot-plate at the trailing end. The steel plate stays to be planed to the exact width required, and securely riveted to the frames by cold rivets. At the leading end, a steel casting with suitable flanges is to be riveted to the frames at bottom, with ⅞-in. rivets pitched zigzag, and this casting is to be provided with a boss for carrying the bogie center pin. This boss to be accurately turned, and to be planed on the bottom side, to suit the bogie cross-slide. This casting must be perfectly square with the frames. The driving-wheels are to be placed 1 ft. 5 in. in front of the fire-box. The driving and trailing axle-box guides to be provided with adjustable wedges having a taper of 1 in 10, as shown, guide and wedge to be of the very best cast-steel supplied by makers to be approved by the Railway Company's Locomotive Superintendent. The top and sides are to be in one piece, free from honeycomb and all other defects, and the flanges are to be planed all over and fitted to template ; they are to be fastened to the frame with bolts 1 in. in diameter, accurately turned and driven tight in the holes. The horn stays are to be attached to the guides as shown on drawing. The frames must be finished with a good smooth surface 1 in. thick, and the axle-box guides must be free from cross-winding and square with the engine in all directions. The rubbing plate on back end of frame for the intermediate buffer is to be of wrought iron case hardened.

BOGIE.

The bogie is to be made of the form and to the dimensions shown on drawing. The wheels are to be placed 7 ft. 6 in. apart, center to center. The frame plates are to be of the same quality as those specified for the main frames, 1 in. thick and placed 2 ft. 7⅝ in. apart. The axle-box guides are to be of the very best cast steel, of approved make, free from honeycomb and all other defects. The flanges are to be planed all over, and fitted to template. They are to be fixed to the frame by bolts ⅞ in. in diameter, accurately turned, and driven tight into the holes. The frames are to be firmly secured to cast-steel stay with ⅞-in. rivets, zigzag pitch. Great care must be taken that the frames when put together are perfectly parallel and at right angles with the steel stay. The cast-steel cross-slide is to be planed on its rubbing surfaces, and bored out to receive the bogie pin. Each side-controlling spring is to be laminated, and is to consist of 16 plates, 2½ in. wide and $\frac{5}{16}$ in. thick. They are to be made of the very best quality of spring steel, manufactured from Swedish bar iron. Each spring must be thoroughly tested before being put into its place by being weighted with 2 tons, and on the removal of this weight it must resume its original form. The top plate of each spring must be stamped with the maker's name and date of manufacture, and be to the same specification as the driving and trailing springs. The plates are to be properly fitted and tempered, and are to be prevented from shifting side or end ways by nibs stamped upon them. The buckles are to be sound forgings, and are to fit the springs accurately, and are to be well secured by a short wrought-iron pin driven while hot through a hole in the top of the buckle, and with a hole in the top plate. Through the center of the casting forming the bogie pin a wrought-iron pin 3 in. in diameter is to pass, fitted at the bottom end with a nut and washer ; the hole in the stay is to be elongated to allow for the lateral motion of the cross-slide. Each spring cradle is to be made of two Yorkshire iron plates 6 in. deep, 1½ in. thick, with cast-iron distance pieces riveted between them at each end ; these cast-iron pieces are to be provided with means of lubrication, and are to be shaped to rest on the saddles formed on the top of the axle-boxes. The springs are to be coupled to the beams by hooks as shown, the pins through the hooks are to be of steel, and the eyes of the hooks are to be case hardened. The brackets holding the springs are to be of Yorkshire iron, and are to be bolted to the frames with 1-in. turned bolts driven in a tight fit. The whole of the work is to be of the best description, and the bogie, when finished, must be perfectly square and free from cross windings and according to drawings.

MOTION PLATE.

The motion plate to be of the very best cast steel, of approved make, thoroughly annealed, to be ⅞ in. thick, planed

and secured to the frames by ⅞-in. turned rivets, countersunk and riveted cold. The motion plate to be properly faced for the attachment of the slide-bars, and to be as shown on drawing.

FOOT-STEPS AND HAND-RAILS.

Foot-steps and hand-rails are to be fixed on each side of the engine in the manner shown. The hand-rails to be carried round front of smoke-box, and to be 1¼ in. outside diameter. The hand-rail pillars are to be fixed to forged brackets, which are to be studded to the boiler as shown. The foot-steps are to be roughed, and the hand-rails to be finished bright.

PLATFORM AND SPLASHERS.

The platforms are to be of Best Best Staffordshire iron ¼ in. thick, secured to frame as shown on drawing. The splashers are to be of plate iron $\frac{3}{16}$ in. thick, of the form and to the dimensions shown on drawing, the rivets to be ⅜ in. in diameter flush outside. Angle-irons to be 1½ in. × 1½ in. × ¼ in.

CAST-IRON FOOT-PLATE.

A cast-iron foot-plate is to be fitted between the frames at the trailing end, to be of good hard metal, free from all defects. The casting to be fixed to the frames by bolts 1 in. in diameter, to have suitable holes drilled to receive the draw and safety link pins, as shown on drawing.

SAND-BOXES.

Two cast-iron dry sand-boxes to be provided, one on each side, in front of the driving-wheels. They are to be so arranged that the valves can be worked together by suitable gearing from the foot-plate; the valves are to be circular. Sand pipes are also to be fixed as shown; the sand to be led within 3 in. of the rails by wrought-iron pipes 1¼ in. inside diameter. The general arrangement of sand-boxes and gear, and the details of the valves and gear to be as shown on the drawings.

BUFFER PLATES.

The buffer plates are to be of steel, same quality as specified for frames, 7 ft. 11 in. long, 1 ft. 7⅞ in. deep, and 1¼ in. thick, and are to be riveted to the stays and angle-irons on the inside and outside of frames, as shown on drawing.

BUFFERS.

The buffers are to be of cast iron to this company's pattern. The buffer springs are to consist of three Spencer's No. 119 india-rubber cylinders, to this company's pattern.

The buffers are to be placed at a distance of 5 ft. 9 in. apart, center to center, and at a height of 3 ft. 6 in. from the rail level.

DRAG HOOKS, SCREW COUPLINGS AND SIDE CHAINS.

The drag-hook is to be furnished with Spencer's india-rubber cylinder No. 6, to this company's pattern. The hooks, screw couplings, and side chains are to be of best iron, chain-cable quality, and according to drawing.

(TO BE CONTINUED.)

THE HANDLING OF FUEL ON THE FRENCH, ENGLISH AND BELGIAN RAILWAYS.*

By M. Jullian.

(*Continued from page 568, Volume LXVII.*)

FUEL HANDLING WITH ELEVATORS.

Arrangements of the Paris, Lyons & Mediterranean Company.—The conditions surrounding the coal handling of the Paris, Lyons & Mediterranean Company are almost identically the same as those of the Northern Company, as far as the multiplicity of the quality of the coal is concerned. The management has, therefore, recognized that it is of the utmost importance that the mixture should be well made, and have adopted an arrangement which will be described later on, by which this mixing is done mechanically. They have at present only one of these mixing shops in operation—that at Pont-de-l'Ane, near St. Etienne; another one will soon be built at Courbesac. The cars are run into the station loaded with lumps or mixtures of various kinds of coal, and even with fine pieces, and they are delivered just as they come, though lump and fine coal is given to the engineers in proportions fixed by the engineer in charge of the motive power. It can thus be taken directly from the cars where haste is necessary, or from the coal heaps where such heaps are built up. As a general rule, the Paris, Lyons & Mediterranean coaling stations are platforms, where loading is done with a basket. There are only two plants at which the tenders are loaded mechanically.

Dijon Depot.—Figs. 17 to 21 show the coaling arrangements at the Dijon depot. It is located in two angular spaces next to each other, but separated by a track reserved for coal cars, and bounded on one side of the angle by the track for incoming engines, and the second by a track which is used for the movement of cars. The space between the two car tracks is used exclusively for coal heaps, and will hold about 14,000 tons of different classes of fuel. In the triangular space bounded by the engine track a plant for mechanically handling the coal has been located. The fuel platform is built of masonry; it has a height of 14 ft. 9 in. above the rails, a length of 155.8 ft., and a breadth of 37 ft. 5.6 in. It is cut up by a system of narrow-gauge tracks with a gauge of 1 ft. 7.7 in. arranged in the following manner: A rectangular belt line runs along the four sides of the platform, with a turn-table at each corner; then 10 tracks of the same gauge and parallel to the short side of the rectangle unite the two long sides by means of turn-tables. This platform is bounded by a balustrade in which there are four openings on the side under which the engines run. These four openings are intended for gangways through which the fuel can be dumped into the tender. The gangways are arranged as follows: The opening in the balustrade is formed along the sides and at the heap by a kind of inclined bridge standing at an angle of 60° with the floor of the platform, and made of angle and star iron; a small fixed gangway having a length of 1 ft. 9.6 in., and of an angular form, rests upon the floor of the platform, is riveted to the bottom of the lifting bridge, and stands at an angle of 45° with a horizontal. Finally, next to this fixed gangway there is another which is movable about an axis parallel with the edge of the platform; the second gangway can be lowered or raised at will by means of a chain operated by a small winch located on one of the standards of the bridge and connected by pulley attachments to the center of the opening of the gangways. The connection of the movable gangway to the fixed gangway is made by means of rings, so as to permit a lateral motion which can be obtained by pulling upon the chains fastened to the back end of the movable gangway and the balustrade of the platform.

The coal is carried in lorries holding 1,000 lbs. each, and like those built by Decauville. A steam or lift elevator is located in the narrow space at the left end of the platform for raising and lowering a cage between the level of the depot tracks and the platform tracks. This elevator is operated by a 4-H.P. machine, that gives it a speed of 7.9 in. per second with a filled lorry when going up, and of 9.8 in. in coming down. Finally, at the level of the depot tracks and parallel with the tracks upon which the cars are placed for distribution, two narrow-gauge tracks are located which are connected together and to the track which runs across the elevator by means of turn-tables.

The work of loading the tenders is done in the following way:

The empty lorries are run over a narrow-gauge track nearest the cars, and are filled by the shovelers with shovels; they are then run on the track nearest the platform and on to the elevator, which raises them, one after the other, to the level of this platform. They first run over the belt line parallel to the cars, which are being unloaded, to a scale, where the head shoveler adjusts their loads until they contain 1,000 lbs., and then they are shunted on to one of the cross tracks.

When an engine is run in to be loaded, the shoveler lowers the movable gangway to the tender, takes the lorries and runs them, one after the other, by the belt line up to a point in front of the gangway, empties them, and pushes them down along the belt line, whence they are run out on to the elevator and taken down.

Time Consumed in the Work.—The maximum number of lorries which can be raised per hour is 32—that is to say, the work is so organized that they can lower 32 lorries, fill them, and replace them on the platform tracks in an hour. As to the length of time of unloading the lorries into the tender, it varies from 20 seconds (when the lorry is standing near the gangway) to one minute, when it is some distance off, and it is necessary to run it over double turn-tables.

At Dijon the work on the mechanically operated platform employs 65 lorries and is done by 12 men—six by day and six by night. The average amount of coal distributed for each 24 hours ranges from 150 to 160 tons. In order to facilitate the night service, a brilliant electric light system has been installed upon the platform, where there is an arc light of 250

* *Revue Générale des Chemins de Fer.*

candle power. As we have just explained the manner in which the fuel is taken from the car and loaded upon the tender, and the time which this work occupies, it now remains to speak of those other operations, which consist in dumping the coal into the heaps and taking it from the same. The coal is put upon the heaps with the shovel by means of a wheelbarrow or basket. The cars to be unloaded are run upon the track alongside the coal pile, and further removed from the platforms. Sometimes it is possible to shunt them upon the track which runs directly alongside the pile; this is the case when the pile that is to be built up is not located opposite the platform.

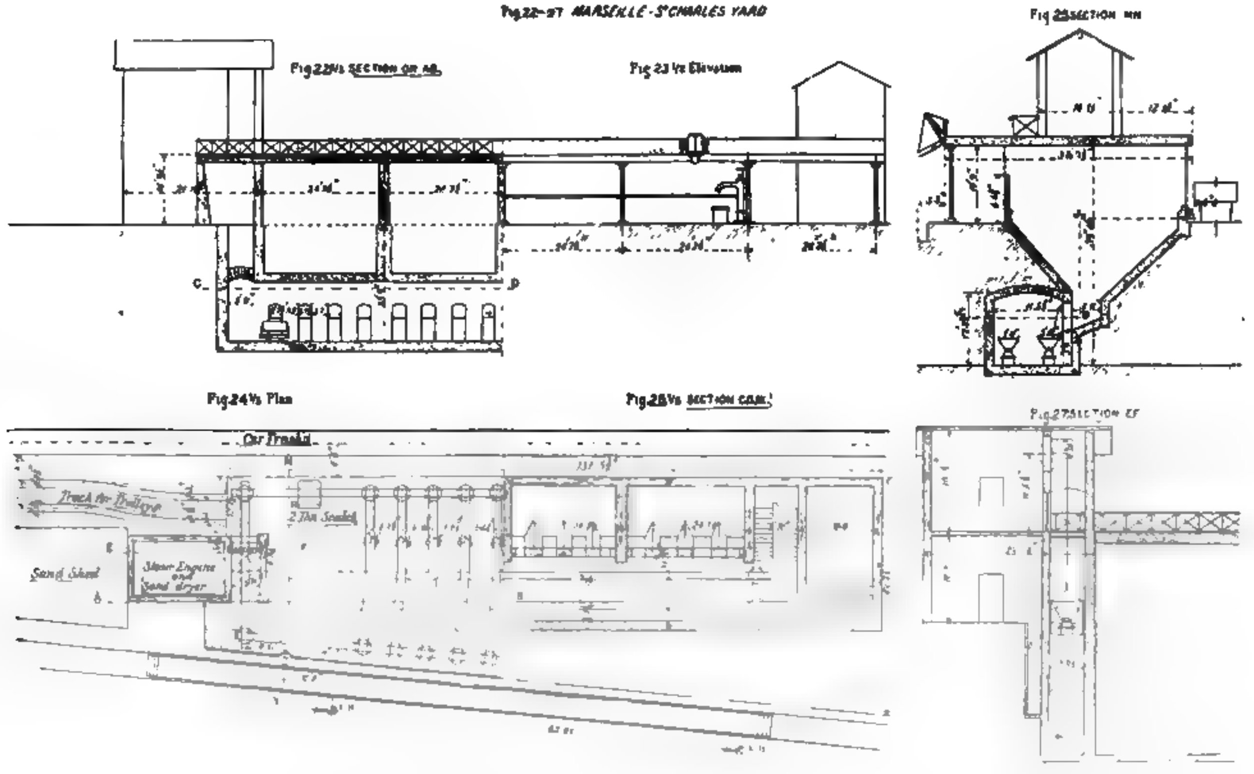
In order to take the coal from the piles and load it on the engines, two methods are used. When that portion which is to be used is opposite a lorry track the shovelers throw the coal upon the floor with a shovel and load it from the floor into the lorries. When the coal is some distance from the lorry tracks, however, they first carry it either in baskets or wheelbarrows to a car which is run as near as possible to the point where the work is done, and it is then hauled on to the track near that of the lorries.

tracks. As there was no place for building up a storage pile, it was necessary to supplement it by a special arrangement, which constitutes the original portion of the plant.

The engine track, as well as that of the cars, was run along the edge on the long sides of the trapezoid, and the platform occupies a space left between these two tracks without any space between for the location of the narrow gauge tracks which are used for the movement of the lorries. These tracks are placed parallel to that of the cars, but in the very limited space left between the wall of the elevator building and the wall of the platform built along the small end of the trapezoid. The platform itself, like that of Dijon, stands 14 ft. 9.3 in. above the ground; it is built on masonry dropping down into the ground to a depth of 31 ft. 6 in., and offering the following peculiarities:

Four chambers of equal dimensions are built along the length of the foundation, and serve for storing coal; above the ground these chambers take the form of a parallelopipedon, with a breadth of from 22 ft. 1.7 in. to 27 ft. 1 in., and a depth of 15 ft. 9 in.; below the surface of the ground they are prismatic in form, and the bottom is arranged in the form of a

Figs. 22–27 MARSEILLE-ST CHARLES YARD



hopper. Above the ground they are open on the side toward the car track and enclosed by a plank partition on the engine side. Below these chambers and along the whole length of the foundation there is a vaulted gangway, on the floor of which two narrow gauge tracks are laid. Each of these four chambers open on to this gangway by means of small windows closed by registers. Finally, a cross track, located at one end of the gangway on the elevator end, makes a connection between the two tracks by means of turn tables and the elevator, so that cars can be run out into the elevator cage.

The various operations are conducted in the following manner:

Loading Direct from Car into Tender.—As at Dijon, the lorries are run upon a narrow-gauge track nearest the cars to be unloaded, filled, raised by the elevator until they are level with the platform, shunted, etc.

Filling the Underground Chambers.—Each chamber will hold about 300 tons of fuel, so that there is storage capacity in them for 1,200 tons of coal. The cars to be unloaded are run up opposite the openings and unloaded with the shovel.

Loading Engines from Coal Taken from the Vaults.—The lorries are lowered into the vaulted gangway and run opposite the register of the vaults; the shovelers fill them by opening the register to the platform and then run them upon the other track and have them hoisted, by means of the elevator. From

The cost of loading from the car directly into the tender, including the handling of the cars, runs from $.0668 to $.073 per ton. To this expense of $.0668 or $.073 a general annual expense for the mechanical work of the platform must be added, namely:

Fireman and elevator man, about	$570
Maintenance of engines	76
Fuel and oil	380
In all about	$1,026

A platform has also been built at Dijon for loading engines with baskets in case the mechanical methods should fail for any reason, and for loading switching engines, which cannot always take the different fuels in quantities of 1,000 lbs.

The St. Charles Depot at Marseilles.—Figs. 22 to 27 show that the space available for this coaling station was very limited, and consists merely of a trapezoid whose parallel sides have a length of 49 ft. 2.5 in. and 36 ft. 1.1 in., and a height of 157 ft. 6 in. A plant for the mechanical handling of coal was built upon this trapezoid, and is arranged in almost identically the same manner as that of the Dijon depot. Everything which has been said relative to the Dijon depot applies to this one, and there is nothing to be added unless it is that there are two gangways for distributing to the locomotive

Fig 17–21 *DIJON-PERRIGNY YARD.*

Fig.17 Plan

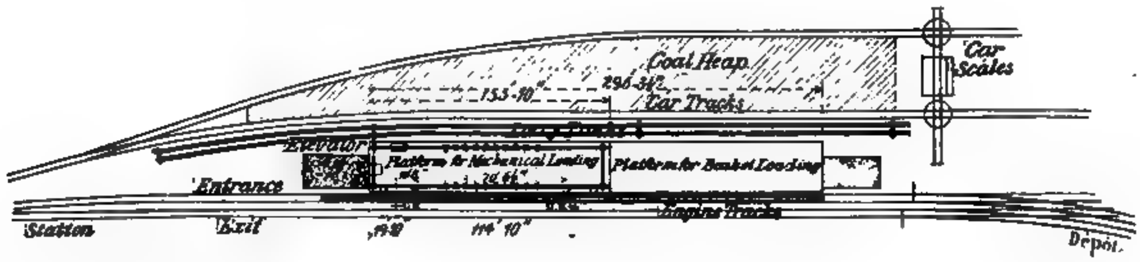


Fig 18. SECTION ON AB

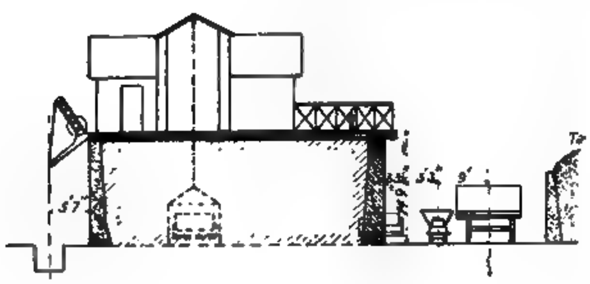


Fig.19. SECTION ON CD

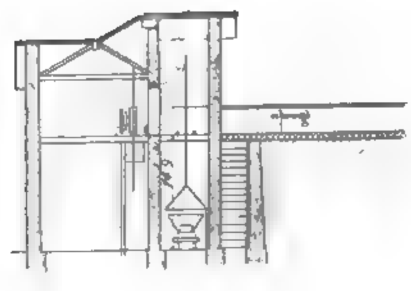


Fig 20 Plan

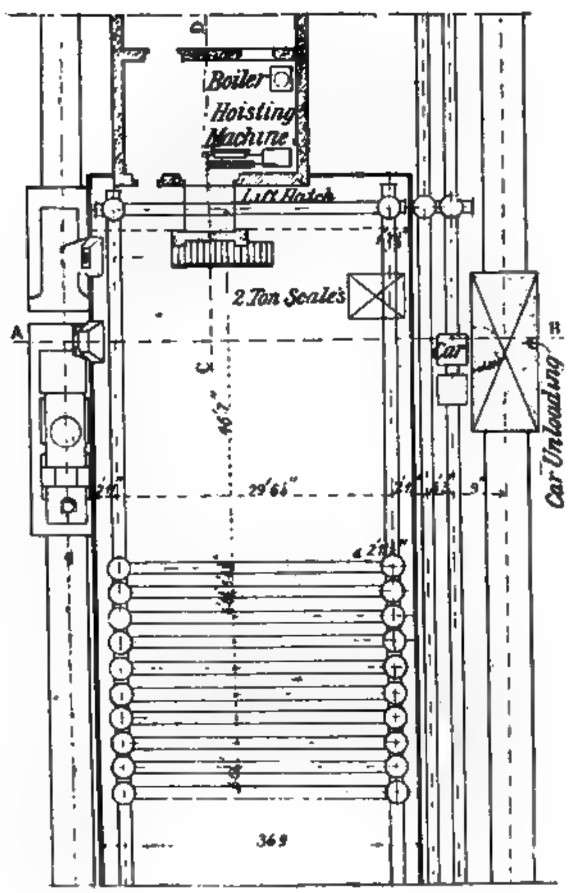
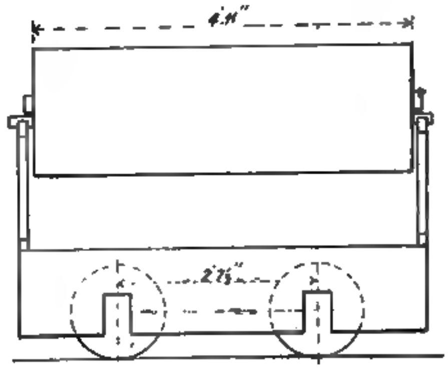
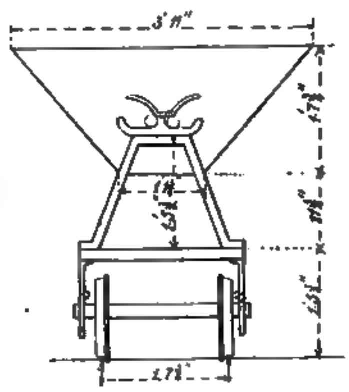


Fig.21 CAR

Elevation



SIDE ELEVATION



this time they are handled exactly as if the fuel had been taken from a car.

The work at this station is done with 75 lorries of 1,000 lbs. capacity each, and from 10 to 14 men are employed, six of them working at night. The cost of loading from the car on to a tender, including the handling of the cars, is about $.072 per ton. The expense of operating the motor, its maintenance, together with that of the lorries, is practically the same as at Dijon; but the interest and depreciation of capital invested in the plant will be greater, for the construction of the subterranean vaults was very expensive in consequence of the difficulties which were met with in doing the masonry work.

The system which has just been described, and which has been applied at Dijon and Marseilles, insures a very rapid loading of the tender; they show the same saving whenever the fuel is loaded directly from the cars upon the tender, but when it is necessary to take it from piles, the saving is less. With the system adopted at Marseilles there is still a considerable saving when coal is taken from the set of large vaults; but in this case the first cost of the plant is greater. The general disadvantage which is presented by this system is its first cost, and the fact that it is not readily adapted to the formation of storage piles. The plant could be very much simplified by doing away with the tracks upon the platform, and this simplification would render the system similar to that adopted in England, and would have the advantage of more rapid unloading of the lorries into the tenders.

Mixing Works at Pont de-l'Ane.—It is proposed at this shop to accomplish mechanically and automatically the mixing of the several qualities of coal, and the loading of this mixture on to cars. The plant is composed of two parts, one where the mixing is done, and the other where the mixture is loaded on to the cars.

The Mixer.—The arrangements where the mixing is done is very similar to the subterranean vaults at the Marseilles coaling station. There is a construction along one side that is divided into seven spaces, open above, and with hopper bottoms opening at the bottom into a vaulted gangway. The cars to be unloaded are stationed upon a track located along the upper platform and as near as possible to the opening of the hopper. The bottom of each hopper communicates throughout its whole length with a vaulted gangway by an opening 4 ft. 7 in. wide extending along the whole breadth of the chamber. In this opening and running its whole length is a drum which is driven by a powerful steam engine. Above this drum, and extending the whole length of the gangway, there is a large endless belt, which is driven by the same motor. The upper half of this belt rests upon a series of small rollers which hold it up, and it moves between two small plank partitions with a very slight play.

The mixing operation is, therefore, accomplished in the following manner: The hoppers are filled with a shovel with the different qualities of coal to be mixed, and the motor is started; the wheels at the bottom of the hoppers break up the coal and cause it to drop down upon the endless belt at the same time; and the latter, in passing under the first vault, receives a layer of coal from it, and then, passing under the second, it is covered with a new layer with another kind of fuel, and thus under each vault in such a way that when it arrives at the end of its run it is covered with seven layers of different qualities.

Automatic Loading.—The endless belt, when it reaches the end of its run, dumps these layers of coal with which it is charged into a new hopper, the opening of which is opposite a conveyer. In this way the fuel carried by the endless belt can be dumped into the buckets of the conveyer. The latter raises the fuel to a height of 72 ft. and 42 ft. 8 in. above the tracks of the upper platform. When the buckets reach the top they dump themselves into another hopper, which carries the fuel into the cars standing at the upper platform upon a track parallel to that of the cars which are unloading. The Pont-de-l'Ane coaling station mixes from 800 to 900 tons of coal a day, and uses 16 coal dischargers, three different operations, and a horse, with its driver, for the handling of the cars.

The cost per ton of coal, unloaded into the vaults, mixed and reloaded into a car, may be divided as follows:

Expense of hand-work, including the foreman, per ton.	$.034
Motor, oiling, loading	.004
Maintenance of plant	.01
Total	$.048

This cost is less than that of mixing with a crane, as done by the Northern Railway Company.

The Paris, Lyons & Mediterranean Company have built at Courbesac, in the basin of the Gard, a similar mixer, with a slight modification in detail. The unloading cars are run upon a track over the vaults themselves, so as to be able to unload from two sides at the same time. The expense will, therefore, be a little less. The other parts of the plant are similar to those of the Pont-de-l'Ane. These plants are evidently very carefully designed and well built, and they will insure a thorough mixing at a slight expense; but it is necessary to remark that they can only be applied to particular cases, where they can be built near several lines which furnish the coal to be mixed, and where they are, therefore, not obliged to carry on a supplementary transportation. Furthermore, they are very expensive in first cost and must be guaranteed constant work, for each day that they stand idle will result in a very sensible loss.

Conclusions.—In looking over the various plants which have just been described, we can see that none of them shows a full, general, and complete solution of the problem of the rapid and economical handling of coal. Each system has been built with a view of accomplishing certain set conditions, others being laid to one side. If we look at it simply from the standpoint of ease and rapidity in loading on the tender, the simplest and most economical is that which has been adopted in England, consisting in running the cars either upon the fuel platform or alongside of it, and accomplishing the loading of the tender by means of lorries of 1,000 lbs. capacity, which are run in any direction on account of the absence of tracks on the platforms. From the different reports which have been gathered together it seems that with this process the loading of a tender with a ton of coal can be done in less than one minute, and that the cost will be from $ 05 to $.066, according to circumstances, and that the plant required is not very expensive; taking all things into consideration, therefore, it is necessary to give the preference to the arrangements of the North British and the Caledonian Railway, both of which arrangements permit the cars to be run upon the platform. It is certain that this system has an advantage in the rapid loading of tenders, even when taking the fuel from coal piles—in fact, it is sufficient to make arrangements so as to always have on the platform either fuel lorries or cars which are easily unloaded; but, then, the supplementary handling necessitated by this method of operation results in an increase of cost of fuel as delivered to the tender.

The system adopted by the Paris, Lyons & Mediterranean Company is somewhat similar to the preceding one, though it is not so simple, and is far more expensive; the movement of the lorries, their rising to the platform by means of elevators very sensibly increases the expense of operation, and furthermore the system of tracks located upon the platform is the cause of delay in handling the lorries, and consequently increases the time required for filling the tenders. This system has, nevertheless, an advantage over the preceding one in that it can be built anywhere, and does not require a great extent of ground for the construction of the incline; it even permits, as at Marseilles, the construction of a coaling station upon a piece of ground which is too small for an ordinary station. Yet it is necessary to bear in mind that the amount of coal that can be stored—that is, 1,200 tons—is insufficient to cover the amount delivered at so important a depot as that of Marseilles.

Finally, the Paris, Lyons & Mediterranean system has an advantage over all of the systems which have been examined into, in that the weight of coal delivered to the engines can be controlled, and consequently the weight received from the mines on the cars verified.

We come at last to the Northern system, which differs entirely from the two preceding ones. In adopting this system it seems that they have sacrificed rapidity of loading to a certain extent, and that they have attempted to secure an economical method of mixing at the same station. The Northern Railway Company is not situated in exactly the same way as the Paris, Lyons & Mediterranean; the coal which they use comes from all points of the system, and they could not think of establishing a central mixing plant, for the transportation to this plant would increase the cost of the fuel far beyond the benefits to be derived. They have, therefore, been obliged to adopt a system of mixing on the spot, and think that they have obtained a good solution of it by the use of the cranes. The object does not appear to have been completely attained, since in almost all the depots the unloading is done with the shovel; but it is, nevertheless, true that in those places where the unloading of the coal into storage piles is adopted absolutely, the use of the crane for loading the tenders constitutes the cheapest method, if not the most expeditious that can be employed. Finally, it may not be useless to recall the disadvantages which exist, in that it does not permit of a careful control over the fuel which is delivered to the engineers, and requires, especially at night, more time for loading the tenders.

THE END.

NOTES ON THE MACHINERY OF THE NEW VESSELS OF THE UNITED STATES NAVY.*

By George W. Melville, Engineer-in-Chief, United States Navy.

I have been asked by the Committee on Publication of the Society to contribute a paper to this first meeting dealing with the matters covered by the title I have chosen. I presume I have been asked to do this, both because I have been identified with the building of our new vessels almost from the start and also on account of my official position, which naturally gives me opportunities for procuring information not open to all. Although much of what I shall give is not new and has already appeared in print, in reports of the Department and elsewhere, still a *résumé* of the whole subject will perhaps be convenient and save the trouble of hunting up the data in so many places.

The building of our new Navy began, of course, with what are known as the Roach cruisers, the *Chicago*, *Boston*, *Atlanta*, and *Dolphin*, in 1883, but I shall not pay very much attention to these, as, while they were the first of our new ships, there is nothing particularly novel about their machinery, except where it would call for rather unfavorable criticism, and I shall therefore begin my account of the machinery of our new vessels with those which were built under Secretary Whitney's administration.

The earliest of our ships were gunboats and protected cruisers, and in order to get the machinery below the protective deck the engines were of the horizontal type. Later, when the idea of fitting the vertical armor around the cylinders had been advanced, thus enabling vertical engines to be used, we adopted them, and have faithfully adhered to them, except in the single case of the ram *Katahdin*, where the circumstances of the case were such as to compel the use of horizontal engines. I ought to say, however, that our engines all come below the protective deck, so that no vertical armor is used, as is the case in England.

It is hardly necessary for me to point out in such a meeting as this the advantages of the vertical engine over the horizontal, although I would by no means give the impression that our horizontal engines are otherwise than very satisfactory. Indeed, the long cruises made by such vessels as the *Philadelphia*, *Yorktown*, *Baltimore*, and *San Francisco*, leaving the machinery in admirable condition, show that these horizontal engines were very satisfactory.

There are so many able minds working at the problem of the best design for machinery that the matter has been pretty thoroughly developed, leaving very little for an ingenious designer except some change in matters of detail.

Passing for a moment the questions of weight and space for machinery, one of the most important considerations for high-power ships is the matter of economy at ordinary cruising speeds. In the old days, where the maximum speed was perhaps 12 knots, it was a very easy matter to run at 8 knots with at least the same and probably greater economy than at full power, but in our modern ships, built to make 18 and 20 knots, it is a very different thing to reduce the speed to 10 knots. The friction alone of moving the immense pistons and other moving parts of the 16,000-H.P. engine when it is developing perhaps only 1,500, deducts a very large amount from the gross H.P. and leaves the net a very small fraction. Besides the matter of friction, there is to be taken account of the immense cylinder condensation in these large engines running at greatly reduced power and with high grades of expansion. This would reduce the economy very decidedly.

Various methods have been attempted to solve this problem, perhaps the earliest of which was the idea of having two sets of engines on the same shaft, one of which could be thrown out at reduced powers. This was first done, as far as I now remember, in the Italian battle-ships *Italia* and *Lepanto*, but has been since repeated in numerous others and is used in our own vessels, the *New York* and *Brooklyn*. Another method, which naturally suggested itself when the number of cylinders was multiplied in the adoption of the triple-expansion engine, was the cutting out of the low-pressure cylinder at reduced powers and running as a compound engine with the two smaller cylinders of the original triple-expansion engines. This would then work up to somewhere near the full power of the cylinders of that size with a reduced pressure, so that, while not nearly as economical as well-designed triple-expansion engines for the power which was actually being used, it would, nevertheless, be more economical than the large triple-expansion engines working at very much reduced power. This method we have adopted on our armored cruiser, the *Maine*, and I believe it is in use on a Russian cruiser and some other vessels.

The next method which suggested itself is the subdividing of the very large power among three engines instead of two, giving us the triple-screw ship, so that at very low speeds only the central engine need be used, the propellers of the side engines being disconnected and allowed to revolve freely. Of course, in this case there is the loss due to the work necessary to drag these propellers through the water, and to offset this is the gain from saving the friction of running two large engines in a twin-screw ship. The experiments by Chief Engineer Isherwood at the Mare Island Navy Yard in 1874, on the power necessary to turn screw propellers when disconnected and allowed to revolve freely, show that the loss in this way is very slight, and there can be little doubt that this will by no means be equal to the power which would be absorbed in the friction of the large moving parts of two large engines. Then, as has already been pointed out, we shall have a single engine working up to pretty nearly its full power, when the steam economy would be good, while in the case of the two large engines working at very reduced powers the steam economy reduced by condensation would be very low. The first of our triple-screw cruisers, the *Columbia*, has just had her official trials, which have been a great success as far as working at maximum power is concerned. Of course, there has been no opportunity yet to determine the economy of working at reduced powers by the use of a single screw, but by a study of the logs of the *New York* and the *Columbia* for a couple of years we shall be able to form a very clear idea as to which of these methods is the better one for economy.

Still another very ingenious method of combining an engine which shall be fairly economical at full power with one which shall have good economy at moderate powers, is the engine which we have just designed to go in gunboat No. 7 of our Navy, intended for service in a light-draft gunboat. The primary conception of this idea is due to Professor Hollis, of Harvard University, until recently one of my assistants in the Bureau of Steam Engineering, and the subsequent working out has been under my direction and modified to suit all the circumstances of the case.

In this case it was desired to combine as many desirable features as possible, so that the machinery was not only to be economical, but to be very light. With this latter end in view, more than two-thirds of the boiler power is in the shape of tubulous boilers, whose weight, as is well known, is, roughly speaking, only half that of the ordinary cylindrical boiler. The special novelty in the design consists in having the engine designed as a quadruple-expansion engine for full power, taking steam to the high-pressure cylinders from the coil boilers, while the remainder of the boiler power, which consists of two cylindrical boilers, will furnish steam to the first receiver, a reducing valve being fitted so that the pressure in the receiver will be just equal to the pressure of the steam discharged from the high-pressure cylinder. Of course, while this is entirely novel, it is really an extension of the idea which has obtained for some time of exhausting from the auxiliaries into the receivers. This provides for full power. At reduced powers the engines will be made triple-expansion by disconnecting the large low-pressure cylinders, leaving the triple-expansion engines composed of the three smaller ones, and the cylinders have been designed so that they have good proportions for economical working as a triple-expansion engine with steam at 160 lbs. The cylindrical boilers are designed to furnish steam at this pressure, while the coil boilers will furnish to the high-pressure cylinders of the quadruple-expansion engine steam at 250 lbs. pressure. Naturally they can work at reduced pressures, so that either of the cylindrical boilers or any of the coil boilers may be used to furnish steam for the triple-expansion engine at moderate speeds.

This question of economy, at moderate powers, is a more complicated one than would seem to be the case at first sight. Doubtless, we have all thought of the fact that the multiplication of auxiliaries, independently of the main engine on board ship, has involved considerable steam consumption which was not applied directly to propulsion, but, so far as I am aware, the matter had never been considered in great detail until Professor Hollis, then a Passed Assistant Engineer in the Navy, discussed it about a year ago in some lectures he delivered at the Naval War College. In a table which he gives, based on the performance of machinery with which he had had personal experience, showing the percentage of steam developed by the boilers applied to propulsion and to auxil-

* Presented at the New York meeting of the Society of Naval Architects & Marine Engineers.

iaries at various speeds, it can be seen at a glance that, at low powers, the proportion expended in auxiliaries is very large. This, of course, has a very material effect on the economical speed and the steaming radius. In fact, it vitiates entirely the theoretical calculations which are made for radius of action by simply taking the H.P. of the main engine at various speeds, and allotting a certain coal consumption for each H.P., and then working out from the bunker capacity. For one of our ships, where the radius of action has been computed at about 25,000 knots at a speed of 10 knots, I had the calculation more carefully done, allowance being made for steam for the auxiliaries, and found that in reality the steaming radius would probably not exceed 11,000 knots.

In this connection it is well to note a matter which has already been discussed a good deal recently in regard to the desirability of detaching all the auxiliaries from the main engine. As we all remember very well, 20 years ago all the pumps were driven from the main engine. Then, as speeds increased, one pump after another was disconnected from the main engine, until finally it was left with nothing to do except to turn the propeller, and as far as smooth working is concerned, nothing more could be desired. Now it is a question of economy that confronts us, and we are driven to consider whether we have done wisely in driving pumps by simple engines, which are very wasteful in steam instead of from the main engine, which, when well designed and properly managed, is vastly more economical. The relative expenditure of steam in the two types is shown by the fact that some feed-pumps which were carefully tested took 120 lbs. of steam per H.P., while even in our naval engines, which are not as economical as the best merchant engines, we probably got a H.P. for about 20 lbs.

At the recent meeting of the International Engineering Congress at Chicago, Mr. Dickie, of the Union Iron Works, made a very strong presentation of the case for making the air-pump an integral part of the design of the main engine, and I would refer those of you who care to go into this matter at length to his excellent paper. He has given the matter careful consideration, and believes that by a judicious design the air-pump can be made to work at any speeds likely to occur with large engines with as great efficiency as when worked independently and, of course, with a vast increase of economy.

This leads me to speak of a design recently prepared by one of my assistants, Passed Assistant Engineer Frank H. Bailey, U. S. N., of an air-pump specially designed to be run from the main engine of torpedo-boats and other fast-running engines. This pump has already been tested, and under adverse circumstances gave a vacuum of 21 in., at a speed of 1,000 revolutions per minute. This speed is higher than anything that has yet been attempted, although we are now building some torpedo-launches which are to run at a speed of nearly 700 revolutions per minute. These boats will have Mr. Bailey's air-pump.

Thus far I have dwelt principally on the matter of steam economy in our engines as modifying the types and arrangement of cylinders, but I want now to speak with regard to another point which has in recent years become of primary importance—namely, weight and space. Modern machinery which does not give at least 10 H.P. per ton is considered behind the age, and, as we all know, in torpedo-boat machinery the figures run very much higher than this, to as much as 40 H.P. per ton. I think we are all agreed that as long as the demand for reduction of weight is made in a reasonable way every one should accede to it, because manifestly, if we could cut our weights in half for the same power, there would be that much more weight available to be put into guns, or armor or coal for a man-of-war, or into paying freight for the merchantman. It is a question in my mind whether the demand in the past has not sometimes been slightly unreasonable and led to rather unfortunate results, but I am glad to say that in our own service we have been entirely free from any such misfortunes.

The boilers have always been the heaviest part of the machinery, and here naturally the greatest efforts have been made to reduce weight. The one with which we have all become so familiar in the last 10 or 15 years has been forced draft. It seems somewhat odd that we should in effect have followed the lead of our English neighbors in this last introduction of forced draft, when, as a matter of fact, the famous Colonel Stevens introduced it in the early part of this century, and it has been in use for years on the steamboats on the Hudson. Then, too, during our late war, Engineer-in-Chief Isherwood built 19 gunboats of the *Chippewa* class, which were also fitted with ash-pit forced draft. In any case, the practice had fallen into disuse, until it was finally reintroduced by the torpedo-boat builders and then taken up by the English naval authorities. Since then every navy in the world has gone in for forced draft, and to some extent it has been applied in the merchant service also, and, in fact, bids fair to become pretty generally used.

I am a firm believer in the benefits of forced draft when intelligently applied, and have no patience with the people who blow hot and blow cold on the subject (as I have unfortunately been compelled to experience during the last 10 years), who, because an accident occasionally happens with forced draft, immediately say that it is an invention of the evil one and that it ought to be abolished altogether. The same line of argument would probably prevent our using any modern methods in any line of work.

As between the two methods of forced draft in most common use—that by closed fire rooms and by closed ash-pits—I am decidedly in favor of the latter when it can be applied. I make this proviso for the reason that some may at once ask why, if I am a believer in ash-pit forced draft, nearly all of our large vessels recently designed have forced draft on the closed fire-room system. It is simply because in a war vessel with a protective deck and minute water-tight subdivision it is extremely difficult, where there is a number of large boilers, to so arrange the blowers for closed ash-pit forced draft as to ventilate the fire-room thoroughly. This is a point which is sometimes forgotten, but if it is, the fire-room would simply become intolerably hot, and while the boilers themselves will work admirably, the men will simply be killed by the heat. The *San Francisco* of our Navy has ash-pit forced draft, and all who have had experience on her and on other vessels speak in the highest terms of praise of the greater facility, convenience, and comfort which attends this method.

It is to be noted, also, with this method of forced draft, that when there is any care at all taken in the fire-room to keep the grate-bars covered, leaky tubes in the combustion chamber are unknown, while with the closed fire-room forced draft they are not at all uncommon.

I shall forego the temptation to dwell on this matter of leaky tubes, merely saying that we have been very fortunate in escaping almost entirely every trouble of this kind, which I attribute, in a large degree, to the fact that we have not attempted to get too much work out of our boilers, and will pass on to speak of another method of forced draft which is very old, but which has only been used on board ship within the last year or two. I refer to the matter of high smoke pipes. Tall chimneys are the most common method on shore for getting a strong draft, but prejudice or conservatism has until recently prevented the application of this practice to use on board ship. The Messrs. Denny, of Scotland, well known for their enterprise in all matters relating to shipbuilding, were the first to call prominent attention to this matter by a vessel built by them called the *Scot*, which had smoke pipes 120 ft. high above the grate and no other attempt to force the draft. I do not know that any accurate experiments have been made with smoke pipes of steamers to determine just what the increase in draft is for each increase in height, but it has been repeatedly stated that, roughly speaking, we may assume 10 ft. of additional height to be equivalent to an additional one-eighth of an inch of air pressure. It can readily be seen, therefore, what a benefit an additional 40 ft. of height would be.

Taking the suggestion made by the *Scot*, when we were designing the *Brooklyn* and the *Iowa*, I asked to have the smoke pipes made 100 ft. high, in which I was heartily seconded by the Chief Constructor of the Navy; but it will perhaps surprise you to learn that our professional opinions recommending this matter came very near being overturned by the artistic sense of a gentleman in the Navy Department, who was entirely ignorant of technical matters, but who thought that the vessel's appearance would be spoiled by these high smoke pipes. He so represented the matter to the Secretary that the latter required me to submit the reasons why I desired to use these high smoke pipes. This I did. As showing the general feeling on this subject, I need only call attention to the fact that the *Campania* and *Lucania* have smoke pipes 130 ft. high, and no other method of forced draft, and I may say that all our new vessels are now being built with pipes of much greater height than formerly obtained.

Another method of forced draft which is now coming into vogue is that known as induced draft, where, instead of closing in the fire-room or the ash-pit and forcing air in, the products of combustion are exhausted from the chimney by large fans. Of course this is only another way of getting the same effect that we get by the use of the steam jet, and with which we have all been familiar for many years, the advantages in this case being that there is no loss of fresh water, which is a precious commodity on board ship. At a hasty glance one would not be prepared to expect very much from this method, but the experiments which have been making for some years

past in England by Messrs. John Brown & Co. seem to show that this method is very promising, and I understand it is to be fitted to some or all of the large vessels which are now building for the International Navigation Company.

The discussion thus far of reduction of weight assumes that the boilers themselves are not changed materially otherwise than for the fitting of the forced draft appliances, but the question has been a very vital one for some time past, and is now of extreme importance whether we shall not entirely abandon the present types of boilers and adopt a very much lighter one by using what are called coil or tubulous boilers. This matter has been discussed so much by so many able minds, that it is unnecessary for me to go into the matter at length here. We all know the great advantages of these boilers in the way of immense reduction of weight, safety against disastrous explosions, rapidity with which steam can be raised, absolute safety against injury from any amount of forcing, and the case with which, if necessary, a boiler can be removed and replaced. Almost the only objection appears to be the fear that they will not be durable, because of the fact that they are composed almost entirely of very thin tubes, and our experience with these tubes in ordinary boilers has not been such as to lead us to expect a very long life from the coil boilers. However, some coil boilers have been in use for five or six years without showing appreciable deterioration, and a few have been used with fresh water entirely for more than 10 years.

We are treating this matter on a large scale on the *Monterey*, where we have four coil boilers of the Ward type in connection with two cylindrical boilers. These boilers have given great satisfaction in their trials, and the cruise of the *Monterey* will demonstrate the matter of their durability. I may say that, in my opinion, if the experience with the coil boilers on the *Monterey* and on other sea-going vessels should prove to be entirely satisfactory, it will only be a short time until the cylindrical boilers will be almost entirely displaced.

While on this question of weight, we must not forget the engines themselves, where the weights have also been very materially reduced. As we are all well aware, this has been due to three causes: an increase of steam pressure, an increase of piston speed, and the use of stronger materials. Piston speeds have more than doubled in the last 15 years, and our larger vessels are now running with piston speeds of about 950 ft. per minute, while some of the smaller ones, like the torpedo-boats, are designed for a piston speed of over 1,000 ft. If materials should go on improving so that we can reduce the weight of our reciprocating parts, I see no reason why piston speeds should not be increased still more, which, of course, would result in still further reducing weights. If we adopt the coil boiler generally we shall also carry very much higher steam pressures, because we already are carrying pressures of 250 lbs. in some of our torpedo-boats with great success. We have greatly reduced the weight of most of the engines by the use of forged steel for piston and connecting-rods, valve-stems and shafting, and cast steel for pistons, valves, bed-plates, and frames, but there does not at present seem to be much prospect of displacing cast iron as the metal for cylinders. If this should come about, we could still further reduce our weights, and, if nickel steel should within the next 10 years become as commonly used as mild steel is now, we would have a big reduction in weight all around. In fact, these questions of high piston speeds and better material hang together for the reason that the limit to piston speeds is now placed by the weight of the reciprocating parts, whose inertia will be so great after passing a certain speed that for the early part of the stroke the piston would be giving out no work, but simply be dragged around. If the reciprocating parts can be reduced in weight, of course the speed can be increased until the limit is again reached.

One matter which has been of great interest to all engineers has been the coal consumption on full power trials. We are all very familiar, doubtless, with the claim we constantly hear that a good triple-expansion engine with high-pressure boilers gives a H.P. for 1¼ lb. of coal. Our own results have never approached this, and estimates of the coal burned on trial trips also tend to disprove it. Finally, we were able on some of our trials to get thoroughly accurate results with the assistance of the contractors, by having the coal weighed in bags of 100 lbs. each, which could be counted as they were emptied and then again counted after the trial was over. In another case a supplementary coal consumption trial was made with half the boilers, and every effort was made to keep the conditions exactly the same as on the full power trials, in that the air pressure was the same and the engines were run so as to work off all the steam formed. As a result of these trials we found that the consumption for full power was more than 2 lbs., and in some cases as high as 2.6 lbs.

In one of my Annual Reports to the Secretary of the Navy, I called attention to the cause of this difference between the economy of war vessel machinery and that of merchant vessels, and we happened to have very reliable data which had been published of the performance of a particularly economical merchant vessel, which was tested by a committee of the English Institution of Mechanical Engineers under the superintendence of Professor A. B. W. Kennedy, F.R.S. I may call attention to the fact that in this ship, the *Iona*, the boiler has a ratio of heating to grate surface of 75 to 1, which I think tells the whole story. In our war vessels we can never exceed a ratio of about 35 to 1, and then at full power we burn a very much larger amount of coal per square foot of grate, thus making our up-take temperatures very much higher than they were on the *Iona*, so that a large amount of heat must have gone up the chimney without doing any useful work. I may say that these coal consumption tests at full power were the first that had ever been made, and I have not learned of any others having been made since. It of course involves considerable trouble and some expense, and it is only right that the Government should be the one to meet the expense, for the information was certainly of great value.

Another matter which has attracted considerable attention in connection with the trials of our new vessels has been the correction of the H.P. calculated from the indicator cards based on the standardization of the indicators.

The early vessels for our Navy were contracted for with the understanding that they were to develop a certain H.P. The contractors felt that with an agreed steam pressure to start with and known sizes of cylinders they could confidently guarantee that they would develop a certain H.P., but we had at that time no reliable data on which to base our speeds, all our information being of foreign ships, and, while I do not for a moment pretend to say that their trials are not conducted with every effort to secure fairness, we, of course, did not know all the circumstances, as we have since about our own ships, and so might be pardoned for feeling a little uncertain. In connection with the contract it was provided that for each H.P. in excess of the guarantee there should be a certain premium, usually $100, and for every H.P. below the contract requirement there should be a fine of the same amount. This made it very important that the H.P. should be determined accurately.

Experiments which had been made to compare different indicators had shown that no indicator is absolutely accurate at any pressure, and, while those well made did not vary a great deal, there nevertheless is a difference which is worth considering, because in the case of a large engine it will make a very decided difference. In one of the earliest of our large ships the H.P. without correction was over 10,000, while when the corrections were applied it was reduced to slightly less than 9,000. This naturally created a great deal of dissatisfaction on the part of the contractors, but it was due entirely to the defects of the indicators which were used, some of which were as much as 20 lbs. different from the assumed scale at the higher end of the range.

This case and one or two others called the attention of contractors to the matter, so that when purchasing indicators to be used they sent them to the New York Navy Yard, where we have the most elaborate and accurate testing apparatus in the world, and they declined to receive any indicators where the errors were more than a certain amount. The makers of indicators, stimulated by these requirements, have faced the problem manfully, and I am very glad to say that there has resulted a very decided improvement in the accuracy of the springs. In fact, not long since 72 springs were purchased from one maker under a guarantee that the error should nowhere exceed 3 per cent., and out of the 72 only seven had to be rejected, and in these the error was really very small and at the lower end of the scale, where the value in percentage of a given error in pounds is of course greatest. For use on a trial trip these indicators would have been extremely satisfactory, and the error was remarkably uniform.

It has sometimes been sarcastically remarked by persons interested in this subject that the indicator corrections are always disadvantageous to the contractor. This is not strictly true, although it is almost always so, but the reason is perfectly simple I think, and I think we can all understand just why it should be so. Let me say at once that I believe the indicator makers have always worked with an honest desire to have their instruments as reliable as they possibly could be. The errors which exist are not due to carelessness of manufacture, but simply to the conditions of the case, which preclude the possibility of absolute accuracy. Recognizing that this was the case, we can readily understand why the indicator makers should have made the instruments so that the error should be on the side of giving a larger H.P. than the true

one, because that is what everybody wants. These Government tests are almost the only ones with which I am acquainted where there has been any effort made to apply the indicator corrections. In other cases the indicators have been standardized, and as long as the error did not exceed a certain amount, they were taken as correct and the H.P. worked out accordingly. As both manufacturers and owners desire to have engines make as large a H.P. as possible and show as low coal consumption per H.P. as possible, it was only reasonable that, as a variation from strict accuracy was impossible to avoid, it should have been on the side of showing the larger H.P. At the risk of wandering a little from my subject, I may just say in this connection that we have been criticised for our method of testing indicators, on the ground that the conditions were not absolutely identical with those under which the indicator was used. This, of course, is true, as nobody has yet been able to suggest a method of testing the indicator which will enable any record to be made for comparison when it is working as rapidly as it is when attached to an engine making 300 or more revolutions per minute. But, on the other hand, the natural answer to this objection is that the modifications of the old Richards indicator by the various modern types came about, because at high speeds the indicator did not give reliable records, and the claim has always been, and still is, so far as I know, that while the modern indicators are thoroughly reliable at high speeds, they are equally so at low ones. If our method of test is not thoroughly satisfactory, it is incumbent on the indicator makers to show at how low a speed their indicators cease to give accurate results.

I may say in this connection that one of the young officers of the Engineer Corps, who had a great deal of experience in this work of testing, began a series of crucial tests at the New York Navy Yard to determine whether there was any error in the methods we had been using, although neither he nor any of the rest of us who had studied the matter deeply believed that there was any error. Orders to other duties took him away before he was able to complete his experiments, but he had carried them far enough to satisfy him that the method employed is entirely correct.

It may possibly not seem strictly germane to the title of this article to bring in the matter of speed trials, but I do so merely to call attention to a method which I had the honor to bring to the attention of the Navy Department, and which was unanimously approved by the Board on Construction of that department, and was used with great success in the trial of the *Bancroft* early in this year. It consisted in a series of progressive trials for the purpose of standardizing the screw and determining accurately the number of revolutions corresponding to a particular speed. Then having laid a curve to show the relation of speed to revolutions, the vessel could be taken to sea anywhere and the continuous endurance trial run off and the speed at once determined as soon as the average revolutions for the entire period were known. Doubtless many of you are aware that the fast Argentine cruiser, the *Ninth of July*, was tested in this way, and I believe several other foreign vessels also have been. This method enabled the speed to be accurately determined with less difficulty than any other which had been suggested. Patent logs are out of the question, and the run over a long course, which the department is now using, involves the attendance of a very large staff of observers and several ships besides the ship which is making the trial. In the case of trials by the standardized screw method, no other observers are needed than those on the ship itself.

The objections to the trial over a long course occur at once to any one who gives much attention to the matter in the difficulty of laying out the course accurately in the first place, and then the fact that everything which may go at all amiss operates against the contractor. One of the great advantages of the standardized screw method, is that in case the performance of the vessel improves from the very beginning the trial may be prolonged an hour or two, and then any consecutive four hours taken as the one on which the record will be based. Of course, it goes without saying that, if the last four hours of the trial are better than the first four, the Government is getting a ship whose excellence has been demonstrated more conclusively than by the performance of the first four hours. An additional advantage of this standardized screw method, is that the progressive trials over the measured mile enable data of great value to the designers of both hull and machinery to be obtained in getting the relation of H.P. to speed at the various speeds run.

Again, at the risk of being considered somewhat away from my subject, I think it may not be amiss for me to say a word which is based on the matter of economy of machinery at low powers of which I have already spoken. This is a design for an economical peace cruiser. I think all who have studied the matter carefully cannot fail to be struck with the idea that it is a mistake to build small vessels of very high speed for duty as cruisers. I mean vessels of, say, 1,500 to 1,800 tons displacement, designed to make 17 or 18 knots. The machinery necessary to produce this power occupies so much available weight that the amount left for coal is relatively small and the radius of action is very limited. These vessels very rarely in peace time are called on to run at a speed anywhere near their maximum, so that as a matter of fact, during their entire lives, barring a war, they are simply carrying around a large weight of engines and boilers which would be useful in an emergency, but which as things actually go are entirely useless.

Now, in case of war, these vessels are not sufficiently powerful to fight any real war vessel, and they are not fast enough to capture any very valuable merchantman, even leaving out of consideration the fact that no vessel would remain under the flag of one of the belligerents in time of war.

It would seem, therefore, that it would be an economical thing for the Government to build a number of vessels which should be intended entirely as peace cruisers, and which in time of war would be laid up. The office of these cruisers would be to go around and show the flag, to look after the interests of American citizens abroad, and in case of necessity, as happened recently at Honolulu and elsewhere, to land troops. Consequently, they should be able to carry a relatively large crew, and should have as large coal capacity as possible.

Now it seems to me that a vessel of about 2,500 tons displacement, with engines of, say, about 1,500 H.P. for full power under forced draft, would fulfill these conditions admirably. This would give us a speed of about 12 or 13 knots at full power under forced draft, so that with natural draft at full power she could steam with great economy at 8 or 9 knots. The coal capacity would be about 675 tons, and, as the arrangement of auxiliaries could be designed with special reference to economy, she could be safely put down for a radius of action of about 13,000 knots at a speed of 9 knots. I would by all means have such a vessel sheathed, echoing most heartily the efforts which my good friend, Chief Constructor Hichborn, of the Navy, has been making for so many years. The boilers and engines of this vessel would be specially designed with regard to the maximum economy at cruising speed, and I believe that a dozen such vessels would save enough during their career to more than pay for themselves.

METHOD OF MANUFACTURING WELDLESS CHAINS.*

By Simon Brunswhig.

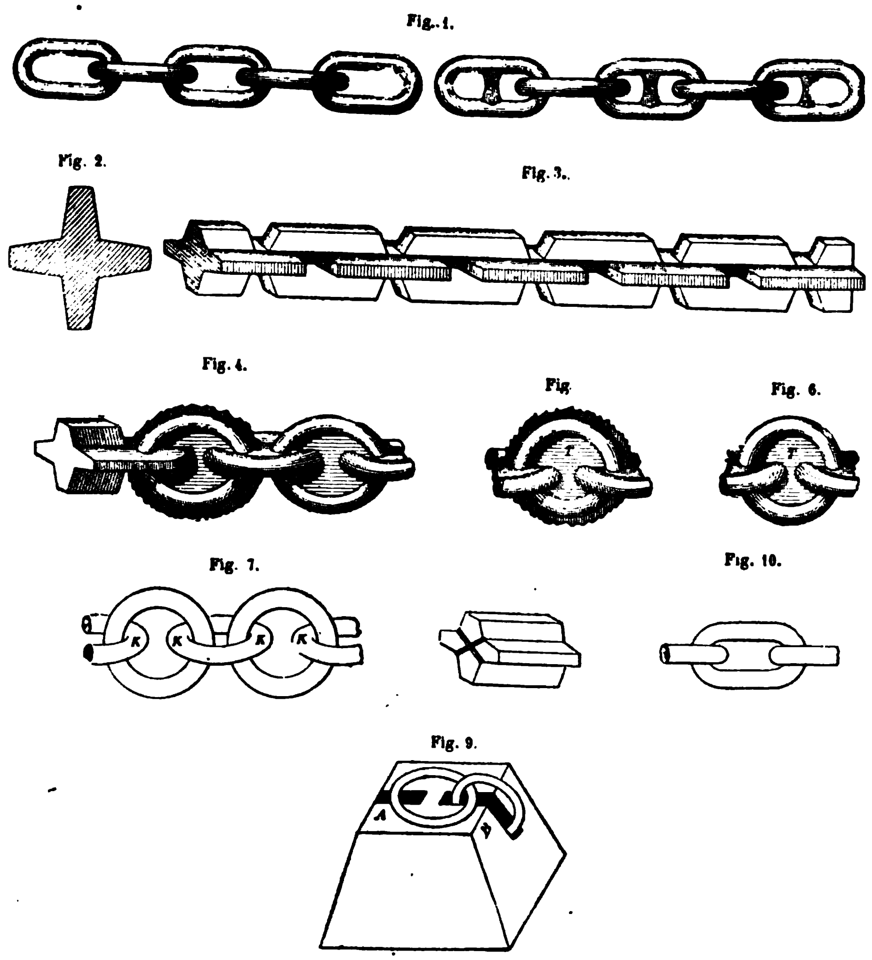
There is hardly any industry where the use of chains is as common, as indispensable, and as important as in the operation of mines, and if iron chains were stronger and more even in their strength their use would be still further extended. In fact, the use of the ordinary iron chain is not without its danger. A bad link or a bad weld may be the cause of a breakage which may have very serious consequences. The weld is, in fact, a permanent danger, for it is impossible to be sure that a weld is perfectly well made even though the outside appearance may not show any defect whatever. The pieces may be perfectly welded together without the center of the link being equally well done, and very frequently a mere sticking is obtained and not a complete weld. So the result is that we are continually hearing of accidents which are caused by the breakage of imperfectly welded chains. For a long time experiments have been conducted in various countries for the purpose of doing away with the weld, and this problem has been solved by M. Oury, who is in charge of the Marine Arsenal at Cherbourg.

The Oury chain is of exactly the same form as the ordinary iron chain, and is shown by fig. 1. It is manufactured by a series of hammerings on soft steel bars, whose tensile strength is from 57,000 to 64,000 lbs. per square inch of section, with an elongation of from 20 to 25 per cent. These bars are first rolled so as to have a regular cross-section of star-shape, as shown in fig. 2.

The star-shaped bars are first heated to a red heat in special furnaces, and are then run through a nicking machine which stamps out the metal with the alternating nicks on each side,

* Paper read at the Mons meeting of the Society of Engineers of the Provisional Industrial School.

as shown in fig. 3. When this is done the small holes, of which we will speak later, are drilled out cold. Afterward the bars are again returned to the furnaces and run under a series of stamping hammers provided with matrices. Figs. 4, 5, 6 show the appearance of the chain after the successive stampings. The hot metal is thus gradually driven into the matrices, and there is a sort of rolling back to the center of the link; the metal flows around the link and leaves only a thin fin of metal in the center. They then remove this thin fin with a punching machine, and afterward proceed to the trimming down of the inside and outside of each link. At this stage of the operation the star-shaped bar has been formed into a length of rigid links, as shown in fig. 7, which must be detached from each other in order to form a true chain. This operation is accomplished by drilling the small holes, of which we have already spoken, and the drilling is done in the following way: Between each notch, at equal and predetermined distances, small holes are drilled which cross each other in paths in the center of the bar itself, as shown in fig. 8, and



METHOD OF MANUFACTURING WELDLESS CHAINS.

which must meet each other in the exact point of contact of the inside of the links, so that the links which are to be separated from one another are then only held together by four bridges of metal which can be easily cut away. This separation of the links is made by a small drop and thus the chain is formed, although the links are still very imperfect, and though not quite round, are still quite independent of each other.

The trimming off is then renewed, and the chain is again sent into the furnace. In coming from the furnace the chain passes under a new series of drops provided with round matrices, as shown in fig. 9, giving the links a circular form. When a link is in the matrix the two connecting links are perpendicular to the first, and drop into the two openings provided in the matrix. These lateral links protect the two parts of the link which are just above them from the blows of the hammer, whence it becomes necessary to turn the link in its form in order that its whole surface may be subjected to the action of the blows. This is the reason why these matrices are round. The hammering is repeated several times, until the fins produced by the stamping are removed, and a weldless chain of round and very regular links is formed. The chain is again heated and passed into an ovalizing machine which crushes each link between jaws and brings it down to the ordinary form, as shown in fig. 10. If the chain is to be stayed the stemples are put in at this time. The chain is thus completed and is allowed to cool slowly in a pit, from which it is taken to be subjected to the tensile tests.

These chains have given some very remarkable results. Among other tests we may cite one made with a .7-in. chain, where the breaking strain was 53,736 lbs., or 68106.40 lbs. per square inch.—*Revue Industrielle.*

UNITED STATES ARMORED CRUISER "NEW YORK."

The armored cruiser *New York*, a summary description of which we published in our issue of April, 1891, is now completed and ready for active service, and has been in commission for several months. We give on pages 24 and 25 a full-page illustration of the broadside and bow views of the vessel as she appeared when anchored in the Delaware River. The other illustrations which accompany the article give a very complete idea of the general appearance of the machinery which they delineate. We give in a detailed drawing a front elevation of one battery of the boilers and a side elevation of the same, neglecting the drawings of the general construction of this part of the steam plant, as well as the engines, because they are almost identical in design with those of the *Minneapolis*, which were published in our issue of September, 1893.

The contract for the construction of this vessel was awarded on August 28, 1890, on the plans and specifications drawn up by the Navy Department, with the addition of certain modifications proposed by Messrs. Cramp & Sons, of Philadelphia, Pa., who are the builders. These modifications included merely a rearrangement of the boilers, so that additional longitudinal and transverse bulkheads could be fitted in the engine and boiler space, thereby affording greater protection to the machinery and making the boilers less vulnerable to attacks from rams and torpedoes. The keel was laid on September 30, 1890, and the vessel launched on December 2, 1891. In accordance with the terms of the contract, the vessel is an American-built ship in every sense. The metal is the product of American mills, and all of the work has been done in American shops. The principal dimensions of the hull are as follows:

Length of water line..................	380 ft. 6½ in.
Molded breadth.......................	64 ft.
Mean draft..........................	23 ft. 3½ in.
Displacement at mean draft..........	8,150 tons.
Maximum speed......................	20 knots.
Sustained sea speed..................	18.5 knots.
Endurance of estimated coal capacity...	13,000 miles.

The vessel carries a complement of 475 officers and men. It is built with four complete decks, including the protective deck, and there is a large flying deck or bridge upon which the boats are carried. These boats include a steam as well as a very handsome electric launch, the latter having been but recently put in position. She carries two military masts and has no sail capacity. Each of the military masts has double fighting tops and a lookout. From her freeboard to her upper deck is about 20 ft., and this, together with her size, will enable her to fight her guns and maintain her speed in a sea which would render a smaller ship practically helpless.

Regarding the general construction of the vessel, the vertical

keel is composed of plates weighing 20 lbs. to the sq. ft., held by lower angles of 4½ × 3 in. weighing 13 lbs. to the foot, while the upper angles are 4 × 3 of 10 lbs. each. The stem and stern-posts and shaft struts are made of cast steel, while the rudder frame is a combination of forged and cast steel. The hull has a double bottom, with a space of about 4 ft. between the two. Forward and aft of the double bottom, which is immediately beneath the machinery space and below the protective deck, the frames consist of Z bars measuring 6 × 3½ × 3½ in. and weighing 15 lbs. to the foot, with their lower ends split for the admission of a 10-lb. floor-plate. Z bars are also generally used above the protective deck frames, and are continuous from the protective deck to the upper deck. The intermediate framing is of the same scantling, and is worked in between the protective deck and berth deck behind the side armor. There are three longitudinals on each side with the double bottom composed of 17½ lb. continuous plates. The beams which are used for the upper deck are T deck beams 10 × 5⅜ in., weighing 31½ lbs. to the foot. For the gun deck there is an angle bulb beam 10 × 3½ in., weighing 26 lbs. For the protective deck there is an angle bulb of 10 × 3½ in., weighing 26½ lbs., and the platforms for angle or Z bars 10 in. or 11 in. respectively.

The outer plating amidships weighs 28 lbs. to the sq. ft. from the keel plate to the shear strut. Toward the extremities the outer plating is lightened to 20 lbs. The plating is double between the protective deck and the berth decks in the wake of the thin armor, and the double plates are worked in the wake of the gun ports, where they are exposed to the chafe of the anchors, etc. The protected portion of the ship consists of a complete protective deck, which at the sides is 4 ft. 9 in. below the water-line, 1 ft. below the water amidships, and 1 ft. above the water when the vessel is at the mean draft of 23 ft. 3½ in.; it is completely covered with two courses of plate having a thickness of 3 in. amidships and 2½ in. fore and aft. The slopes amidship are covered with an additional thickness of 3 in., making their total thickness 6 in.

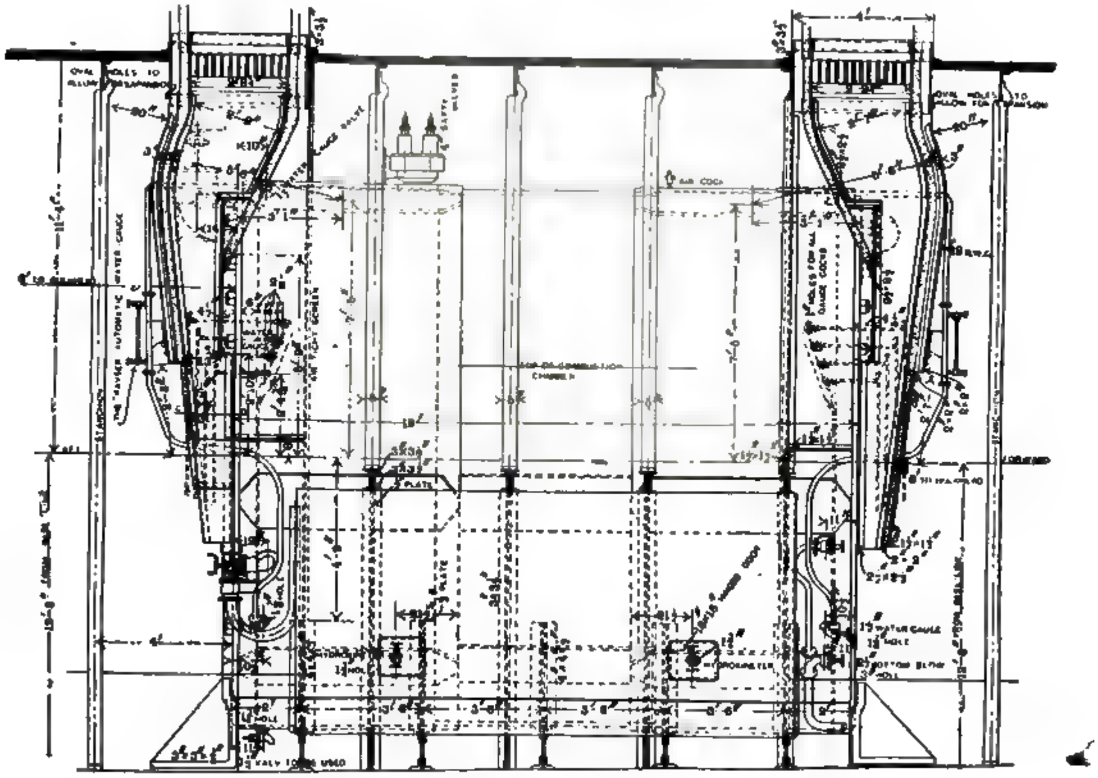
Then there is a partial belt of armor. In the wake of the machinery space the belt of thin armor is worked between the protective and berth decks, and the total thicknesses of metal throughout this space is 5 in. The cofferdam is 3 ft. 6 in. deep, and is worked in between the protective and berth decks, extending completely around the vessel, and this is filled with an improved water-excluding material.

A large proportion of the coal supply is stowed on the armor deck, forming an additional safeguard against the effects of damage near the water-line.

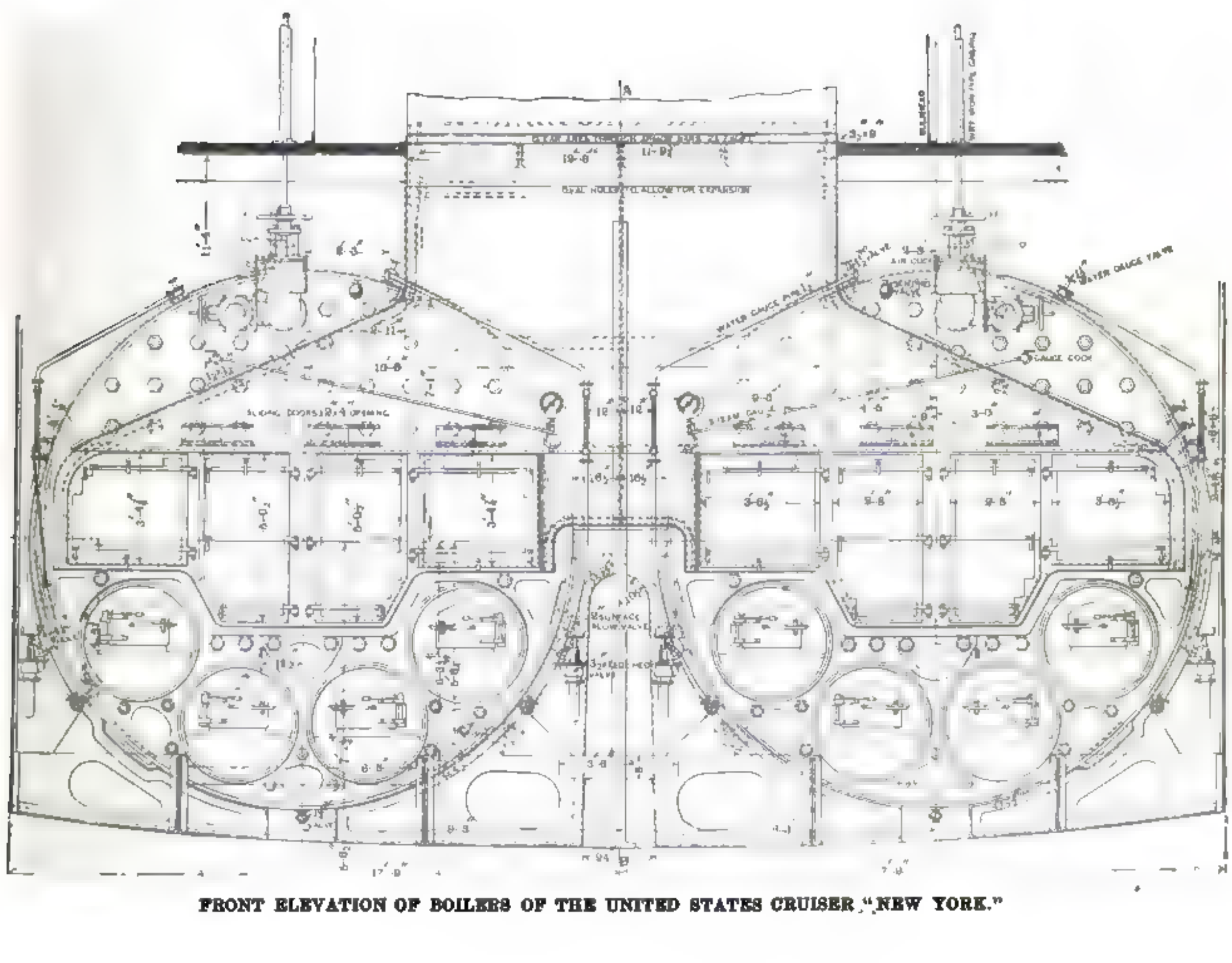
The battery of the vessel consists of six 8-in. breech-loading rifles, twelve 4-in. rapid-firing guns, eight 6-pdr. rapid-firing guns, and four 1-pdr. rapid-firing guns, four Gatling guns, and six torpedo tubes. Two of the 8-in. guns are mounted in a barbette forward on the upper deck, and two more are in a similar barbette aft, while the remaining two are carried in broadsides amidships on the upper deck. The barbettes in which these guns are placed are 10 in. thick, while the revolving conical shields on the guns themselves are 7 in. The sloping armor between the upper and gun decks beneath the barbette is 5 in. thick, while the ammunition tubes below are also 5 in. The 8-in. broadside guns are protected by partial barbette 2 in. thick and shields on the guns. The 4-in. rapid-firing guns are mounted on the gun deck in armored sponsons which are 4 in. thick and which have shields on the guns closely covering the ports. Their protection is further insured by 1 in. splinter bulkheads. The 6-pdr. guns are protected by 2-in. armor or its equivalent. There is one torpedo tube in the bow, one in the stern, and two training on each broadside, each being above the water-line by about 4 ft. The 8 in. guns are 25 ft. and the 4 in. guns 16½ ft. above water.

The vessel has a complete electric lighting outfit, which is arranged in accordance with the most recent practices of the service. There are three search-lights on the vessel, one forward and one on either end of the flying bridge amidships. The military masts are of steel with internal arrangements for the ascension of men and the whipping up of ammunition for

BOILERS OF THE UNITED STATES ARMORED CRUISER "NEW YORK."

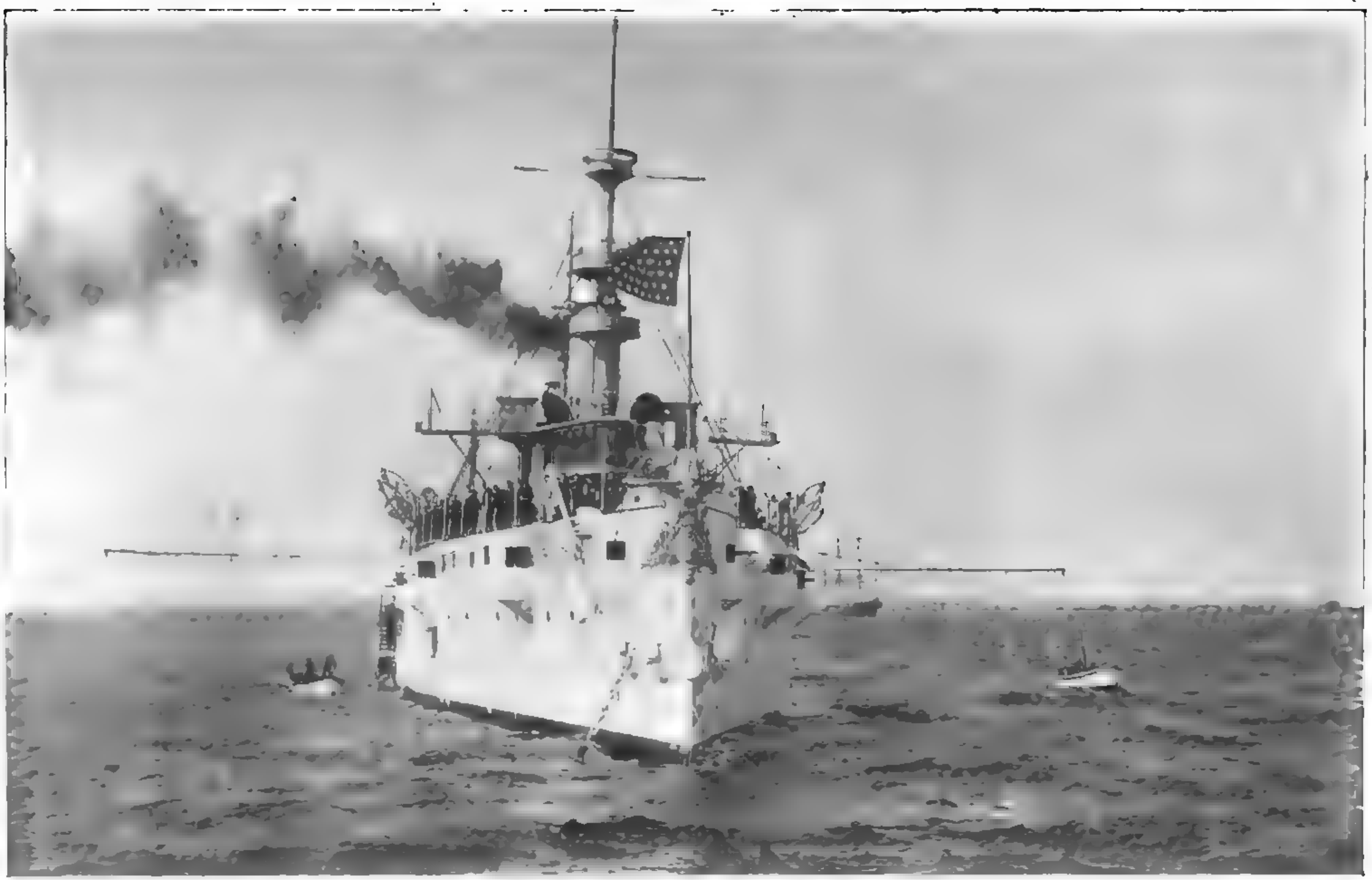


SIDE ELEVATION OF BOILERS OF THE UNITED STATES CRUISER "NEW YORK" FROM SECTION ON LINE A B.



FRONT ELEVATION OF BOILERS OF THE UNITED STATES CRUISER "NEW YORK."

THE UNITED STATES ARMORED CRUISER "NEW YORK."



THE UNITED STATES CRUISER "NEW YORK"—BOW VIEW.

the rapid-fire guns which are mounted in them. Davidson steam steering gear is used, but it is also possible to disconnect this and steer by hand from a bridge just abaft the mainmast should any accident happen to the steam apparatus. Forward there are three wheels for handling the vessel, one on the bridge, which is unprotected, and is used for entering the harbors and handling the vessel in fair weather. Beneath this there is a wheel and chart-house, which is protected from the weather, and has the general appearance of the wheel-house of an ordinary river steamer. This is intended for use in bad weather at sea. Beneath the chart-house is the conning tower, where a wheel is located, which is, of course, only intended for use in time of battle. All of this apparatus is placed just forward of the mainmast.

The most recent improvements in engine and rudder indicators are duplicated in each of these three positions. There is an indicator which shows the speed and direction of each engine. Opposite this there is another engine-room indicator which shows the rate and speed of the last order which had been issued from the bridge, and the two should, of course, correspond, except at the very instant of the issuance of the fresh order. There is a telephone communication with all of the vital parts of the ship, and also telephone communication with the switch-board, which is practically the central office of the telephone system, at which connection can be made to other portions of the vessel.

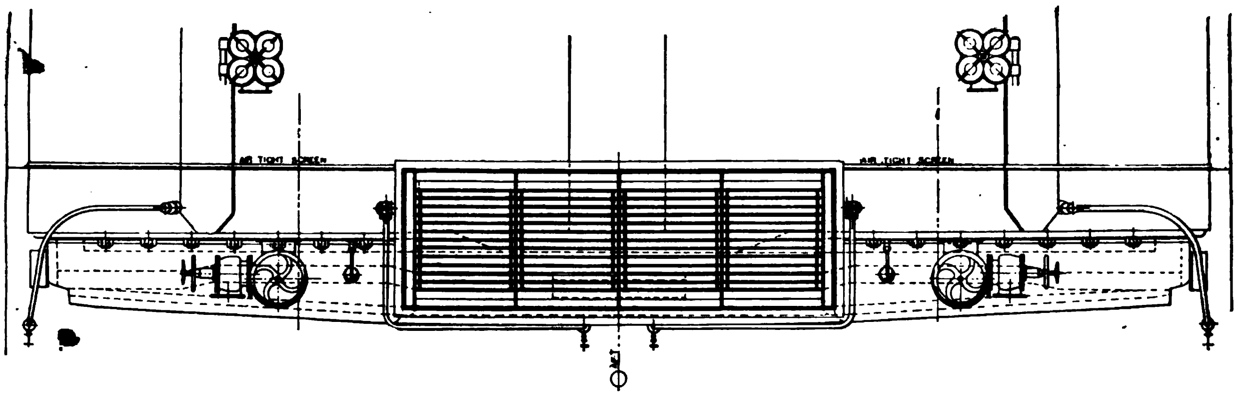
The chart-room is a large, airy apartment, where all the charts of the vessel are kept, and it is handsomely finished in mahogany. The crew's quarters are remarkably clean and airy. The hammocks are stowed on the upper deck during the day and slung from the overhead beams of the berth deck at night. There are ample arrangements for artificial ventilation throughout the whole vessel, and in the living quarters there is a natural ventilation in addition. Great care has also been taken that the pumping and drainage arrangements should be thorough and effective. The vessel is fitted as a flagship, and in addition to the quarters of the admiral and captain there are state-rooms for 20 ward-room officers, 12 junior and two warrant-officers. The interior fittings of these apartments are in oak, with furniture upholstered in handsome leather. Scattered about the ship in various points are the flags and other things which have been presented to the officers and the ship by the citizens and various societies of the city of New York.

In the construction of the vessel there is a longitudinal bulkhead running between the engines and the starboard and port boilers, but forward and aft of this there are no longitudinal bulkheads, but simply transverse, which are closed by the usual type of water-tight doors.

The machinery of the vessel consists of four vertical triple-expansion engines. It was thought advisable to divide up the power of the vessel in this way in order that for ordinary cruising one-half of the available power may be used for economical workings. This is in accordance with the policy which has been laid down by the Navy Department, and which is brought out very prominently by Mr. Melville in his paper on The Machinery of the New Vessels of the United States Navy, published on another page of this issue. Each of these engines is of about 4,000 indicated H.P., and they drive twin screws, two being placed upon each shaft. By means of an easily worked coupling the forward engines are readily disconnected, so that the after set can be used alone; and as these can be worked at nearly the power for which they were designed and at full boiler pressure, the economy will not be reduced as in the case where a triple-expansion engine is worked at a low power and under reduced pressure. There is, of course, some disadvantage in using engines designed in this way, as it results in an increase of weight and a space occupied by the machinery as well as in a greater number of parts that are liable to become deranged; but, in the opinion of the chiefs of the department, it is considered that these are outweighed by the advantages of economical workings, which we have already mentioned. The engines are direct-acting and have cylinders of 32, 46, and 70 in. in diameter, with a common stroke of 42 in., giving a collective indicated H.P. of 16,000 when the engines are making 125 revolutions per minute, with a resultant piston speed of 903 ft.

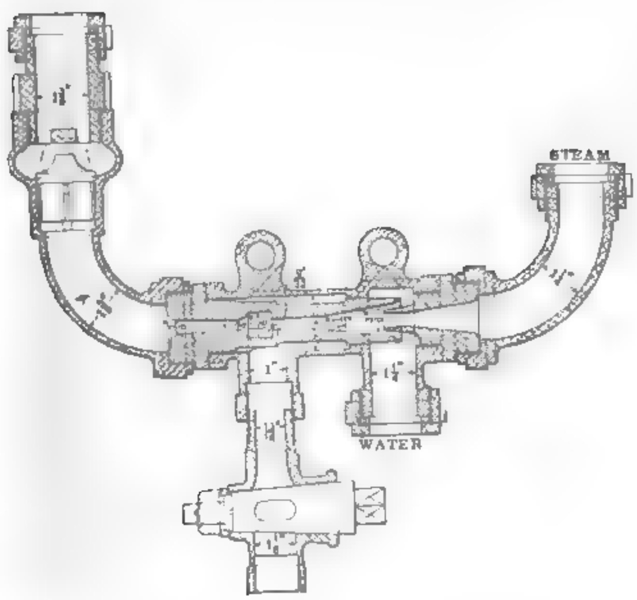
The general appearance of the engines is almost identically that of the engines used on the *Minneapolis*, which we illustrated in our issue of September, 1893. The principal differences between the two lie in the fact that whereas the low-pressure cylinder on the *Minneapolis'* engine was furnished with four valves, the engines of the *New York* have but two; and, also, that while the front of the *Minneapolis'* engines was held by round vertical columns, there is an inverted Y frame on each side of the *New York's*. The diameters of the cylinders are also different, but, with the exceptions which we have already noted, the general appearance of the engines is practically the same.

Regarding the details of the dimensions, piston-valves are exclusively used; they have a diameter of 16 in. for the high-pressure cylinder, with a mean diameter for the low-pressure cylinder of 29¼ in. All the valves are driven by double-bar Stephenson links. The intermediate and low-pressure cylinders are jacketed on the sides and bottoms, while the high-pressure cylinders are fitted with a lining or wearing cylinder of hard cast iron. All of the pistons are of cast steel. As we have already said, the cylinders are carried by inverted Y frames made of cast steel, to which the cast-iron guides are bolted. The bed-plates are of cast steel of an I section, and are securely bolted to the engines' keelsons, which are built in the ship. The piston connection and other working parts of the engines are of mild steel, as well as the crank-shaft, which is forged in three sections for each engine. The forward shafts are 13¾ in. in diameter, with 6 in. axial holes, while the after shafts are 17 in. in diameter with 7½-in. axial holes, so that the shafts are not interchangeable There is a cast-steel coupling between each forward and after engine crank shaft, which occupies but little room and by means of which the engines can be quickly coupled or uncoupled. Each engine with its auxiliaries, such as pumps and condensers, is located in a separate water-tight compartment, and is entirely independent of the other. The main condensers are made of a cast composition and rolled brass, and are bolted and riveted together. They are made of three sections 5 ft. 9 in. in diameter, with a total length of 9 ft. inside tube sheets. Each condenser contains 3,775 seamless drawn tubes No. 20 B. W. G. thick, tinned on both sides, which gives 5,559 sq. ft. of cooling surface. Each tube is separately packed at each end, and is free to expand independently of the others. The condensing water is supplied by a separate centrifugal circulating pump for each engine which has a capacity of 8,000 galls. per minute, which may be discharged either through the condenser or directly overboard by way of the outboard delivery, and may be taken from the sea or bilge at will. The pumps are driven by engines attached directly to the main shafts. The air-pumps are vertical single-acting lifting pumps, each with two pistons of 19 in. in diameter and 18 in. stroke. They are driven by vertical engines with cylinders 7¼ in. in diameter and a stroke the same as that of the pump placed directly over



HORIZONTAL SECTION THROUGH BREECHING AND UPTAKE, UNITED STATES CRUISER "NEW YORK."

it. The air-pump engines are simple, but the steam from them may be exhausted into either the intermediate or low-pressure receiver as well as into the condenser, and so be worked with a full measure of economy. Steam is supplied by six double-ended steam boilers placed below the protective deck and two auxiliary boilers placed above it. The main boilers are 15 ft. 9 in. outside diameter and 18 ft. long. They are double-ended, with four fire-boxes at each end, placed in corrugated furnaces of 3 ft. 7 in. outside diameter, and composed of metal $\frac{11}{16}$ in. thick, each being 7 ft. $1\frac{1}{2}$ in. long. The tube sheets are 6 ft. 6 in. apart. These boilers are almost identical in design with those which were fully illustrated in September, 1893, in connection with the cruiser *Minneapolis*, except at the top and ends; the end sheet of these boilers is brought up square and flanged over with a very short radius instead of being given the broad, long sweep and curve that appears in the boilers of the *Minneapolis*. These boilers are located on either side of the longitudinal bulkhead, and are placed in separate water-tight compartments in batteries of two, so that each battery is entirely independent of the others. Our illustrations show the general appearance of the arrangements of the front of this battery. There is a passage-way from one fire-room to the other between the boilers and through the gangway, which is clearly shown upon the engravings. This gangway is 21 in. wide at the top and 24 in. at the bottom and 6 ft. high above the floor-line. The side elevation of the arrangement of the boilers shows the connections which are made with the bridge and the run to the stack. It will be seen that the bulkhead comes very close to the front of the boiler, and there is but little space in the fire-room for coal heaps, so that the supply must come in continually. The figuring and lettering on the engravings give such complete details of the construction and the arrangements of the boiler that further detail regarding it is unnecessary. For the type and arrangement we would refer our readers to the engravings published of the boilers of the *Minneapolis* in September, 1893.



INJECTOR, GRAND TRUNK RAILWAY.

The heating surface of the main boilers is 31,190 sq. ft., and the grate area 988 sq. ft. The auxiliary boilers above the protective deck have each two steel corrugated furnaces 2 ft. 9 in. internal diameter, with a total heating surface of 1,937 sq. ft. and a grate area of 64 sq. ft. The main boilers have 572 $2\frac{1}{4}$ in. steel tubes, but in the auxiliary boilers the tubes are $2\frac{1}{4}$ in. in diameter. The main boiler shells are butt riveted, with inside and outside welts triple riveted. The thickness of the shell is $1\frac{11}{32}$ in., and the working pressure is 160 lbs. A mild forced draft is used on the closed fire-room system. The screws are three-bladed propellers with adjustable blades, and are made of manganese bronze. There is also a complete hydraulic plant for supplying and working the battery and operating the turrets.

The final trial of the *New York* was ended on December 14. This was an endurance trial to ascertain the action of the ship in service conditions. The coupling on the two forward engines was accomplished in a little less than 20 minutes after the order was given. The result of the turning trials was also highly satisfactory in all respects. The cruiser showed her ability to turn in a circle three times her own length, and with one propeller backing and the other going ahead the vessel was swung around a circle which was only 275 yds. in diameter. The following table shows the approximate result of the turning trials:

Evolution.	Time of Putting Helm Over, Seconds.	Number of Revolutions on Straight Course. Starboard Engine.	Port Engine.	Number of Revolutions on Curved Course. Starboard Engine	Port Engine.	Estimated Diameter of Circle in Yards.	Time to Complete Circle. M.S.
Helm hard a-starboard, both screws ahead full speed	35	82	80	79.5	70 0	400	5 35
Helm hard a-port, both screws ahead full speed	34	..	..	72.8	73 0	350	6 01
Helm hard a-starboard, starboard screw ahead, port screw astern half speed	19	..	..	87.5	68 8	375	5 51
Helm hard a-port, port screw ahead, starboard screw astern half speed	20	.	.	70.0	87.5	350	5 58
Helm hard a-port, port screw ahead, starboard screw stopped	16	..	..	....	72.3	350	6 48
Helm hard a-starboard, starboard screw ahead, port screw astern	14	..		73.5	74 8	275	7 29

From full speed ahead the time from signal "Stop!" to entire loss of headway was 9.07. The estimated distance traversed was 750 yds. From full speed ahead it was found that the vessel could be brought to a stand-still by reversing her engines in 1.46, and before she had run her own length. With both propellers making 102 revolutions per minute the speed of the vessel was 15.93 knots per hour. Owing to the great foulness of her bottom, no higher speed could be gotten out of her. Forced draft was not used.

After the turning trials the firing tests were had. Two charges were fired from each of the main-battery guns, and five from each piece of the secondary battery. Common shell was used with service charges.

The vessel has thus passed all the requirements of the Navy Department, and been shown to be one of the finest vessels of the new Navy.

GRAND TRUNK RAILWAY INJECTOR.

We illustrate an injector which is made by the Grand Trunk Railway for use on their locomotives. It is perhaps not widely known that the Grand Trunk Railway manufacture nearly all of the apparatus and fittings which they use on their engines and cars. Inasmuch as there is a high protective duty in Canada, and as the manufactures of Canada are not extensive enough to supply all of the requirements of a railway, it has been found by the Grand Trunk Railway that it is cheaper to manufacture their own goods than to import from the United States and pay the custom house duty. The injector which we illustrate will be seen to be very simple in construction and readily accessible for repairs. The general dimensions are given on the engraving, and from an examination of the parts it will be seen that they are very substantial and require the minimum amount of machine work in their construction. The steam and delivery pipes, as well as the suction pipe for water, are large, and the combining tube has an ample delivery into the delivery pipe, where there is a check-valve through which the water passes before reaching the long run to the boiler check.

Protecting Metals from Rust.—According to the *Polytechnisches Notizblatt*, articles of steel and iron can be protected against rust by coating them electrolytically with peroxide of lead. A satisfactory coating can, it is said, be obtained in 20 minutes, and is perfectly proof against atmospheric influences. As the whole operation is conducted at ordinary temperature, the temper of steel articles is unaffected by it.

THE GOVERNMENT NEW LOCATION FOR THE RAILROAD ACROSS THE MAIN CAUCASUS RANGE.

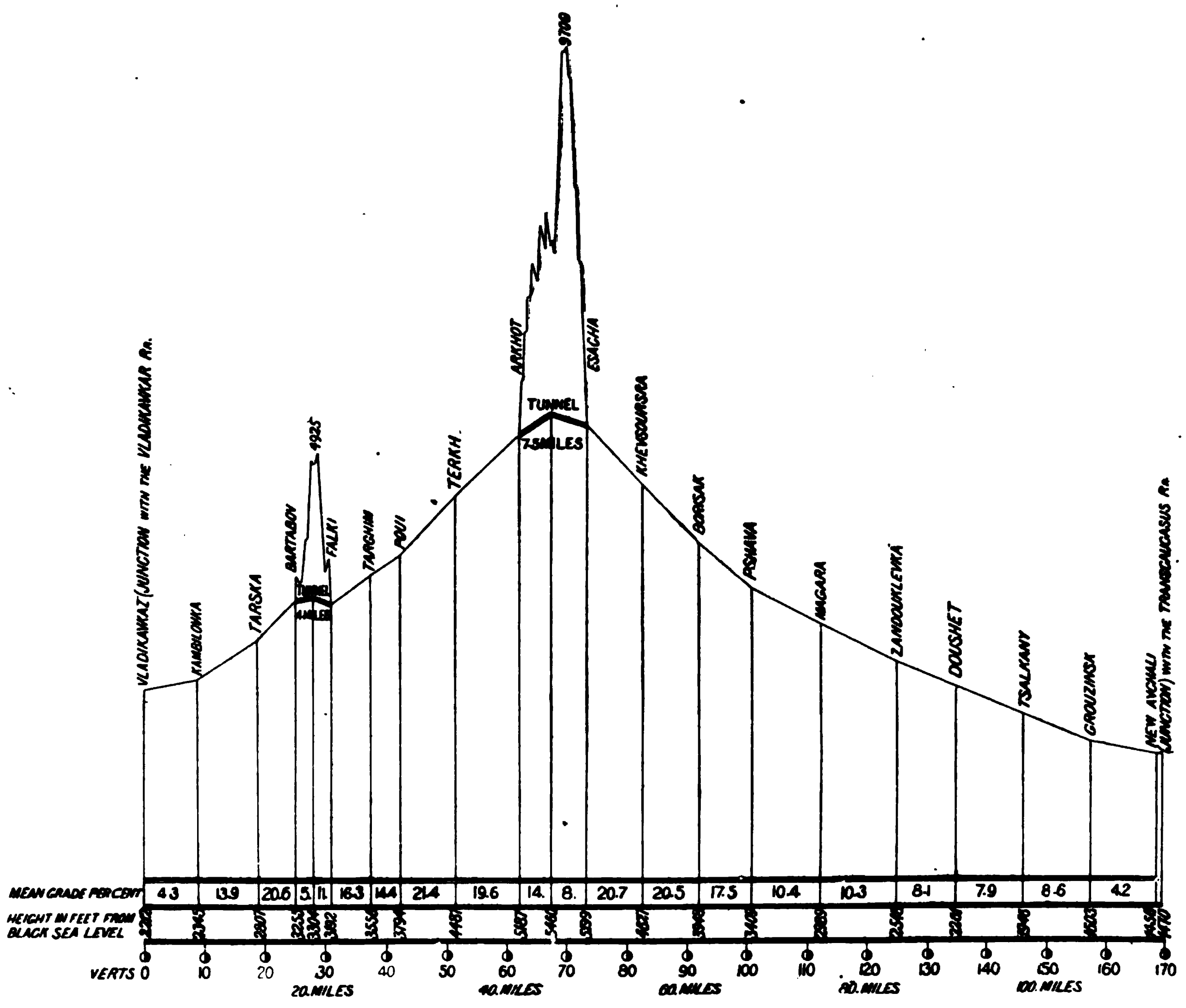
By A. Zdziarski, C.E.

(*Continued from page 587, Volume LXVII.*)

To describe the main features of the located line we must divide it in two parts, southern and northern, each of which consists of two sections, the level section and the mountain section.

The southern level section, 44 miles long, with ruling grade 1.5 per cent., starts from the station New Avchaly, of the Transcaucasian Railroad, and follows the valleys of Koura (8 miles), White Aragva (28 miles), and Pshava Aragva (18 miles). The valleys are so large and their slope so small that the line is located on their bottom, except when small headlands spiral tunnels with a radius of 700 ft. This lengthening of the line reached 17,848 ft. The mountains consist of argillous slate and partly of crystalline slates.

The main Arkhot tunnel has the length of 7.58 miles. It consists of a middle level 1,400 ft. long and 5,475.05 ft. high, and two grades to both portals—the southern grade 0.8 per cent. and northern 1.4 per cent. The absolute height of the summit on sea level is 9,699.7 ft. The range consists here of paleozoic argillous slate (schist). The northern slope contains a layer of crystalline diabase. The southern slope is covered by alluvium, which allows agriculture to the height of 6,000 ft., and from 6,000–8,000 ft. produces Alpine prairies. On the northern slope prairies are found from 6,000–7,000 ft., and under 6,000 ft. the mountains are completely covered by coniferic forest. On the summit the time free from snow is from June 20 to September 1; near the portals from May 1 to October 1. In deep and narrow cañons on the height of 5,000 ft. the snow remains all the year round.



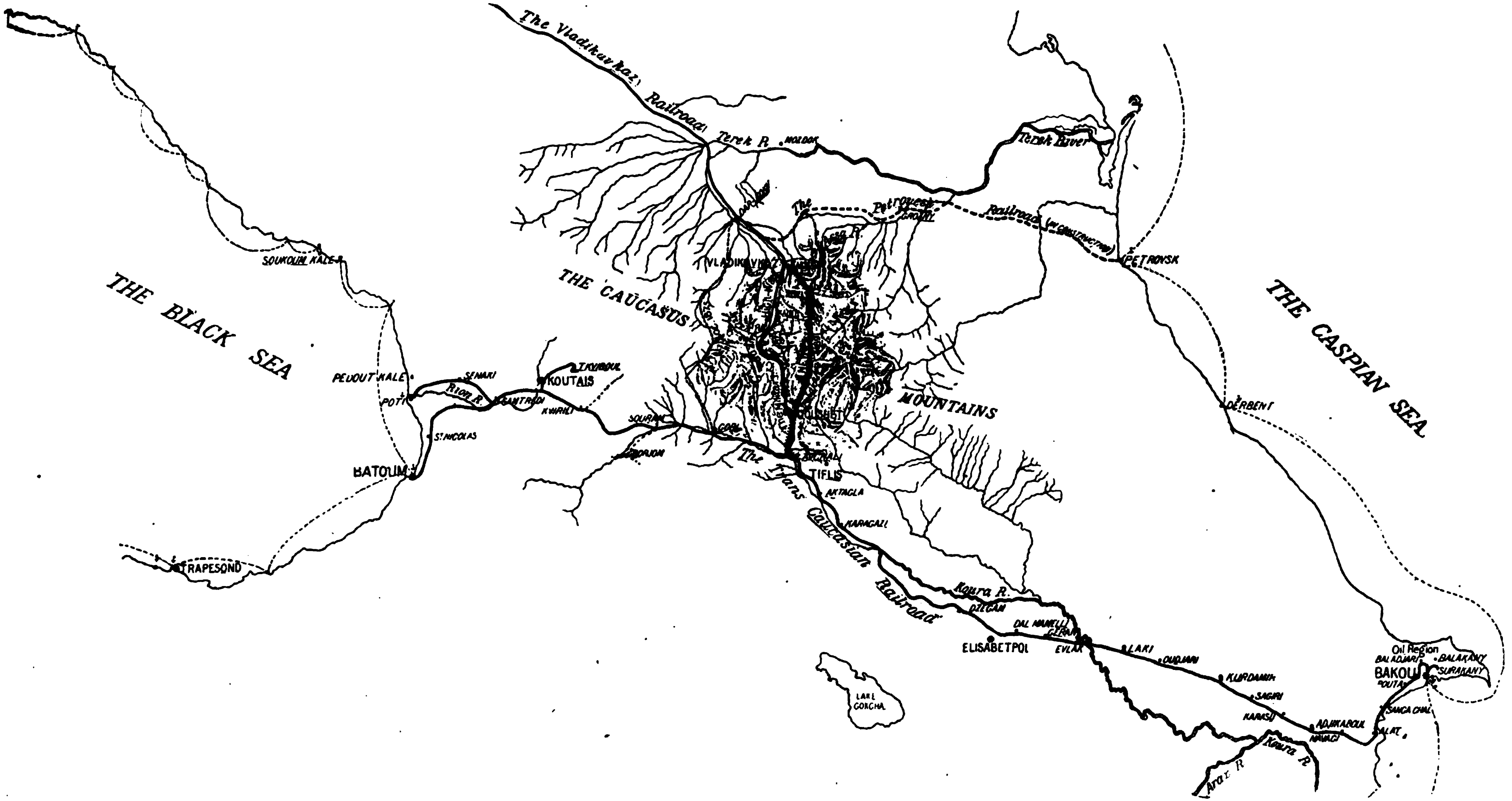
PROFILE MAIN LINE OF TRANSCAUCASIAN RAILROAD.

or ridges were to be crossed, or when narrows were met. The neighboring mountains consist of argillous slate (schist). Other stones, as limestone and sandstone, are found only in narrows, the former in Zinvan narrow, and the latter in Magar narrow.

The southern mountain section, 18 miles long, with ruling grade 2.8 per cent., follows the upper end of the valley of Pshava Aragva, and then the narrow or cañon of Khevsour Aragva (14 miles), and ends at the southern portal of the main tunnel. The valleys of these rivers become still narrower, and the slope of their bottom still greater, but up to the station Borisac the line can yet be often located on the bottom of these valleys. Near that point a tunnel 3,129 ft. long must be designed, for the slope of the bottom of the cañon is greater than the maximum grade of line, and the location must apply to an artificial lengthening of the line, which, thanks to the narrowness of the cañon, could be made only by means of

The main tunnel is designed for double track; it will require 1,272,000 cub. yards of cutting and 352,600 cub. yards of masonry. The motive power for the air compressors, ventilators, etc.—about 1,000 H.P.—can be got from mountain rivers, which on the southern side give a minimum discharge of 100 cub. ft. per second, and on the northern side 170 cub. ft. per second. This discharge, combined with the slope of these rivers, 5 to 7 per cent., can furnish the required motive power on each side.

The northern mountain section, from the northern portal to the Kambilavka station, is 35 miles long, and its maximum grade is 2.8 per cent. From the northern portal of the main tunnel the line descends the cañon of the river Assa, the slope of which, on its first 7 miles, considerably surpasses the maximum grade of the line. Therefore the same must be lengthened by 22,603 ft.; and as the cañon is very narrow and tortuous there, many deep cuttings, tunnels and retaining walls



MAP OF MAIN LINE OF TRANSCAUCASIAN RAILROAD AND CONNECTIONS.

have been designed. The neighboring mountains consist of more strong paleozoic argillous slate (schist), crossed by many crystalline layers. From the estuary of Nelka River (in Assa) the valley of Assa becomes larger, and its slope is less than the maximum grade of the line, so that the location is laid on the bottom of the valley. Near Targim station the region of Touraic limestones begins, and is crossed by Assa River, which has cut a narrow for itself. From the following station (Falki) the line was studied in many directions, from which that going through Tarska was selected.

This line begins with Tarska tunnel, 4.05 miles long, with a middle level and two grades—1.1 per cent. to the eastern portal (3,192 ft. high) and 0.5 per cent. to the western portal (3,255 ft. high). The height of the middle level is 3,306 ft., and that of the summit 4,925 ft. From this tunnel the line enters the narrow valley of Kambilavka River, and then the wide valley of Tara River; but the general slope of this valley is so great that till Tarska station, the grade of mountain location must be allowed. Starting from Tarska station, the line follows the Kambilavka cañon (narrow), where the grades are 2 per cent., and reaches the Kambilavka station.

The remaining portion of the line, from Kambilavka to Vladikavkar, 6 miles long, is located as a level section.

Resuming the above data, we get the following figures:

The total length of the line—

The southern level section	45.17 miles.
" northern " "	6.15 "
" southern mountain section	18.33 "
" northern " "	35.00 "
" main tunnel	7.58 "
	112.23 "

According to the curvature, this length is so divided:

Straights	70.10 miles.
Curves with radius of 1,400 ft. or more	15.90 "
Sharp curves, with radius of 700–1,400 ft	26.23 "
	112.23 "

According to grades:

Levels	14.93 miles.
Grades 1.5 per cent. or less	59.90 "
Grades from 1.5 to 2.8 per cent	37 40 "
	112.23 "

The Design and Cost—The road-bed for single track (5 ft. wide) is designed 18.2 ft. wide. The total quantity of earth-work is 12,833,000 cub. yards, or about 115,000 cub. yards per mile. The greater part of earth-work.—63 per cent—is embankments. From the balance—37 per cent.—the 25 per cent. are cuttings in ordinary ground, and only 12 per cent. in stone of various hardness.

The retaining walls are designed of the type adopted for the St. Gothard Railroad and the Oufa Zlatooust Railroad, and with the provision that the second track could be laid. The total length of them is 32,277 ft.

The culverts are designed of stone 3¼ and 10¼ ft. wide, and are small, 2¼ ft. wide, of cast iron. Their number is 148. The abutments of small bridges up to 28 ft. in height are designed with buttress walls. The higher abutments are designed with inside wells, the application of arches being insecure in mountain country, with foundations on inclined strata. The number of small bridges and aqueducts up to 105 ft. span is 205; the number of great bridges and viaducts (with span more than 105 ft.) is 32. The most notable constructions of that kind are four viaducts on the northern section, with total length of 1,666 ft.; one viaduct on the mountain section 210 ft. long, and a bridge 105 ft. span, also there, and four viaducts on the southern section, with total length of 1,218 ft.

The chief feature of the design is the abundance of tunnels; there are 42 small tunnels for single track, of total length 55,247 ft., and two great tunnels, for double track, of total length 61,086 ft. All the tunnels have been divided in three classes: 1. The main tunnels, very long, where the line crosses the dividing ranges; they are straight and for double track. 2. The spiral tunnels, intended for artificial lengthening of the line in the case when the slope of valley is greater, as the maximum grade of the railroad and the small width of the valley does not allow an open lengthening of the line.* 3. The ordinary small tunnels in such places where the line meets any lateral mountain head, or must be protected by the tunnel against the snow avalanches.†

* The radius of curve is 700 ft.; they are designed for single track.
† Designed for single track.

The types of tunnels for double track were adopted the same as applied in construction of the Souram tunnel. There are designed six different types of tunnel profile, according to the quality of ground.* For the small (single-track) tunnels, eight different types have been designed.

Special snow-sheds are designed for protecting the railroad against snow storms in mountain portions of the line. In level section the snow shield will suffice. These snow-sheds are designed for single track and of light type, from timber framework, covered with planks in manner of shutter blinds (persienne), which can be shut from the wind side and opened from the opposite side for the escape of the smoke. The cost of such sheds with iron roofs is estimated at about $20 a foot.

The solid snow-sheds as protection against avalanches were not found sufficiently secure, and are not allowed in the design. As more secure means against avalanches, three devices have been designed: one to go under the path of an avalanche in a tunnel, one to lay the line on the other side of the valley, where the avalanches do not occur, or to pass over the avalanche by means of a bridge.

The width of ballast-bed will be 10¼ ft., and its thickness 17 in.; the ties of pine or oak 8 ft. long, 2,360 for a mile. In great tunnels the ties to be metallic, each weighing 108 English pounds.

The rails to be of steel, 72 Russian pounds (66 English pounds) to the yard. The joints will be angle splices, with two underplates fixed by means of four bolts and spikes, and will be placed between the ties.

The line buildings are designed of three types: large and small watchmen's houses and section-houses. Eighty-seven small and 14 large watchmen's houses are so distributed that there is a watchman at each mile of the line and at each level crossing of the railroad. For each roadmaster, with his gang of trackmen, a section-house (18 in number) will be built. All the buildings to be of stone, with sheet-iron roofs. There will be 64 road crossings, protected (as above said) by gates and watchmen.

The station buildings, in consequence of the sparse population of the country, need not be large; they are designed of stone, with iron roof, 10 in number, two of them being of the third class and eight of fourth class.

The engine-houses are designed of the size necessary for three trains daily in each direction. They are five, and have altogether 21 stalls. They are designed of stone, with iron roofs covered with galvanized sheet iron. Each engine-house contains a small repair shop.

The buildings for the officers and employés of the operating staff are designed to be of stone or wood, with iron or timber roofs.

The stations and water supply are designed with the supposition that the trains will be driven on the first 53.16 miles, from New Avchaly to Pshava (level section), by one engine; on the remaining portion, from Pshava to Vladikavkaz, the same trains will be driven by two engines. According to them, two large engine-houses (in Vladikavkaz and Pshava) and two small ones must be built.

The water supply is designed for the requirements of 14 trains daily in each direction, it being assumed that each train wants from 11 to 13 cub. ft. per mile, and on the mountain section double that quantity. According to these data, the quantity of daily water supply was computed, varying from 8,000 to 18,000 cub. ft. The providing of stations with water is in a very favorable condition on that line. As the railroad follows the valleys of considerable mountain rivers, the discharges of which are above the necessary water supply of stations, therefore this water supply is quite guaranteed. Besides, for the greater part, the topography of the country allows water to be supplied by means of gravity and without pumping. Steam engines will very seldom be required. The standard water-tanks are of boiler plates, having a capacity of 1,370 and 2,740 cub. ft. Two hydraulic cranes will be placed at each station.

For the equipment of stations, 84 switches, three large turntables, 21 switch-houses, and other accessories are to be used.

The rolling stock is designed for one passenger train and two freight trains daily in each direction. The train will consist of 34 military cars or 24 loaded freight cars. The average speed in mountain section, 10 miles; in level section, 13¼ miles an hour. According to this data, 344 freight cars are required. The passenger rolling stock, designed of the American type (on eight wheels), will consist of four cars of first-class, eight second class cars, 15 third-class cars, four baggage cars, and three prison cars. The engines, 56 in number, eight-wheeled, will weigh 48 tons. The mean annual mileage of such engines is placed at 12,000 miles.

* A special description of types can be a subject of a special article.

The estimates of the route give the following cost of the line (112.28 miles):

		Cost in roubles.
1.	Expropriation, lands, etc.	451,290
2.	Earthwork	7,846,185
3.	Bridges	6,164,055
4.	Tunnels	31,815,320
5.	Track	3,183,180
6.	Road accessories	149,572
7.	Telegraph line	113,744
8.	Road building and gates	336,030
9.	Station buildings	591,400
10.	Water supply	175,000
11.	Station accessories	164,550
12.	Rolling stock	3,418,106
13.	Roads and temporary roads	1,579,440
14.	General expenses	3,878,332
	Total	59,366,145

The principal part of cost belongs to the construction of tunnels—viz., 54 per cent. of the total cost. The cost of construction of the main Arkhot tunnel was estimated at 414 roubles ($207) per foot; the cost of second great tunnel (Taraka) was estimated at 281 roubles ($140) per foot.

In order to compare this estimate with those of St. Gothard's and Arlberg Railroad, we give the following table:

	Arkhot Proposed Railroad.	St. Gothard's Railroad.	Arlberg Railroad.
The whole length of the line, miles	112.28	66.98	40.33
The length of main tunnel, miles	7.58	9.31	6.42
The length of remaining tunnels, miles	14.58	11.58	0.27
The length of open line, miles	90.07	48 04	33.64
The maximum height of the open line above sea level, feet	5,302.5	3,757	4,272
Cost of main tunnel in dollars:			
Total	$8,240,793	$10,390,000	$7,671,000
Per mile	1,087,366	1,015,555	1,233,074
Cost of the remaining part of railroad with other tunnels in dollars:			
Total	$21,442,230	$15,614,000	$5,326,800
Per mile	204,302	264,555	176,530
Cost of the whole railroad in dollars:			
Total	$29,683,073	$26,168,000	$14,222,000
Per mile	264,444	379,532	352,630

From this table it is obvious that the estimate of the proposed railroad does not exceed the costs of the great European Alpine railroads: however, in virtue of the protectionist system in Russia, a great many articles—viz., rails, iron bridges, rolling stock, working machines, cement, etc.—are considerably dearer than in Western Europe.

SPECIAL TOOLS OF THE PHILADELPHIA & READING RAILROAD.

HORIZONTAL DRILLING ATTACHMENT.

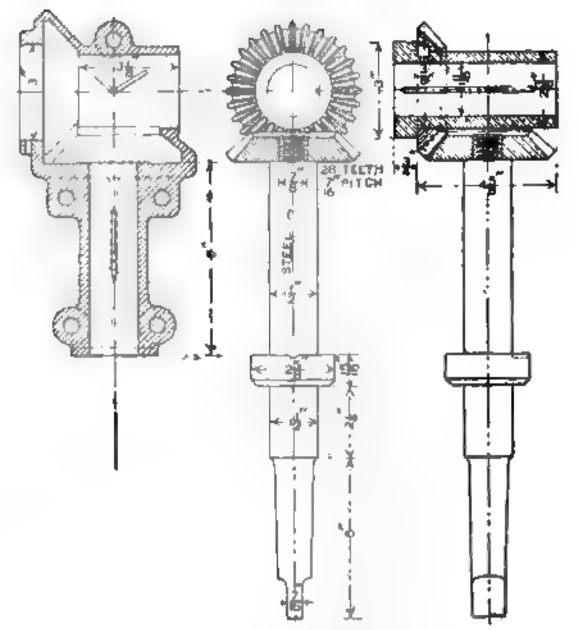
The days when the drilling of bolt holes in pedestals and other similar parts of a locomotive, which were difficult of access in the ordinary drilling press with a hand-ratchet, are undoubtedly of the past. We illustrated in our issue of June, 1893, a drilling device attached to a flexible shaft and driven by an electric motor which would do this work very satisfactorily. The little tool that is used in Reading shops, herewith illustrated, is arranged to work from the drill socket of any ordinary portable drill that may be too large to crowd into the space from which the hole is to be drilled. It consists of a frame casting shown at the left of our engraving. In this two beveled grooves with their shafts are run. At the outer end of one of these shafts there is a shank which goes into a No. 5 socket from which the power is to be derived. The beveled gear which meshes in with this is keyed to a steel sleeve having a slot cut in it, into which a feather is laid and through which the spindle carrying a drill socket works. The spindle is forced down against the work by means of a screw working on the same principle as that used for the feed of an ordinary ratchet.

ONE-TON TRAVELING CRANE.

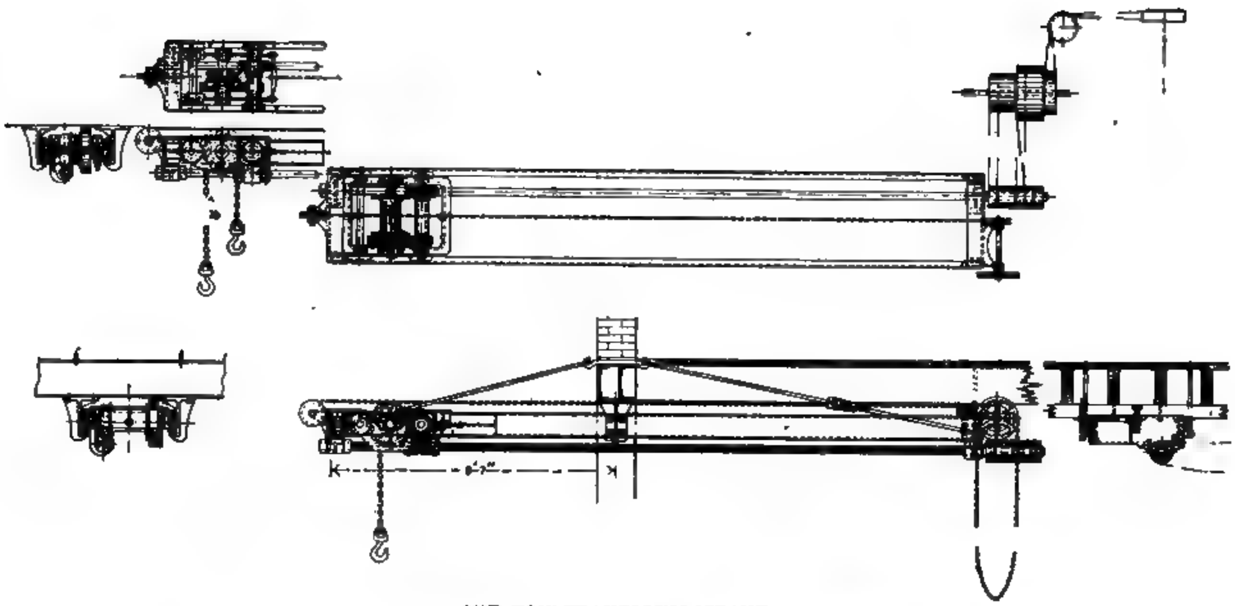
A very convenient power traveling crane is located in the frame shops just under the roof. The crane itself consists of two 8-in. channel beams, which are held to the wall of the building by brackets, as shown in the engraving. This bracket is bolted to a cast-iron beam which is built into the wall. The channels are also trussed by the truss rods, as shown, which have a turn-buckle for adjustment. The carriage is racked in and out by means of a chain-wheel located inside of the building. Immediately below this is the hoisting shaft, which is driven by belts shifting on to tight and loose pulleys admitting of reversal in the ordinary way. This shaft has a key-seat throughout its whole length, and carries an endless screw meshing in with a worm gear on the carriage. The endless screw is also carried in bearings on the carriage, so that its relationship with its worm-wheel is always constant. The belting is so arranged that the lift is at the rate of 20 ft. per minute, while the lowering is done at the rate of 30 ft. per minute. The details at the upper left-hand corner of the engraving show the general construction of the carriage. The chain-wheel is made to revolve eight revolutions, and designed to carry 1,464 lbs. per tooth. The hoisting chain is a $\frac{5}{8}$-in. chain. The driving shaft, which runs from end to end of the crane, is designed to make 170 revolutions per minute, is $2\frac{1}{4}$ in. in diameter, and 22 ft. long. It is a very convenient and rapid running hoist, which can be readily built by any shop which has occasion for its use.

PNEUMATIC HOIST.

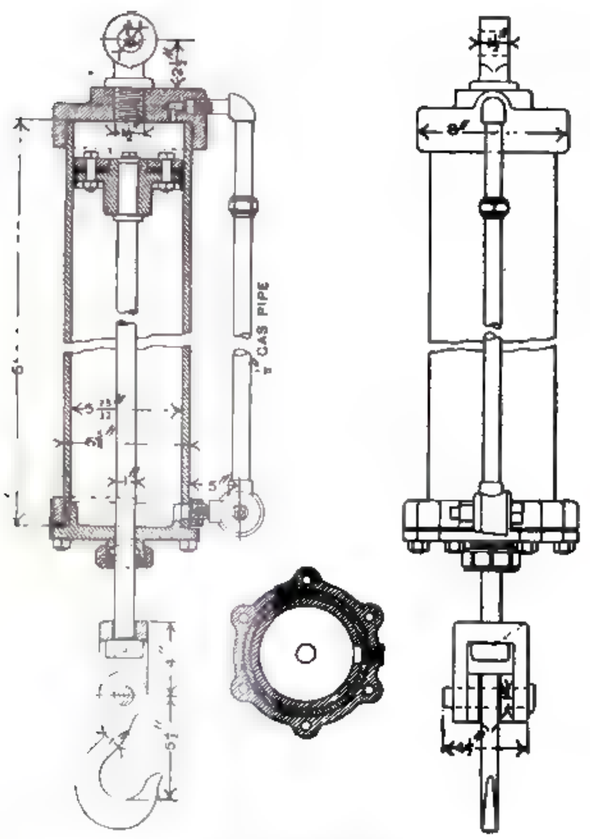
In the article which we have published descriptive of the Special Tools of the Delaware & Hudson Canal Company, we have given a very complete and comprehensive list of hydraulic pressure appliances as used for hoisting. In the Reading shops there is a small pneumatic hoist which is giving very good results. Between the advocates of hydraulic power and compressed air there is, as our readers are probably well aware, considerable earnestness of debate, each arguing that their own special system is the more economical of the two. Each one, however, seems to be perfectly practicable, and the desirability of installing one or the other in a railroad shop will depend to a great extent upon the pressure which is most convenient. Where there is an air pressure available in the shop, the hoist which we show will certainly be a very proper one to install. It consists of a cylinder bored out to $5\frac{15}{16}$ in. in diameter, with an outside diameter of $6\frac{5}{8}$ in. It is 6 ft. long over all, and is made of a piece of 6-in. extra heavy wrought-iron pipe screwed into a head at the top, which is provided with an eye-bolt for suspending the hoist. At the lower end a ring is screwed upon the pipe, to which the lower head, with the stuffing-boxes, is bolted. The piston is the ordinary cast-iron head, with a follower holding a cup packing in position. The piston rod is 1 in. in diameter, and is attached to the yoke of the hook by a nut held in position by a split key. The arrangement of the piping is clearly shown. The pipe making connections between the top and bottom pressures of the cylinder is $\frac{1}{2}$-in. gas pipe. Our other engraving, showing the valve used for operating the hoist, gives a very clear idea of its design. It is shown in cross and vertical sections, and the valve is attached at the lower end of the vertical pipe, as shown by the engraving. The valve is a self-packing



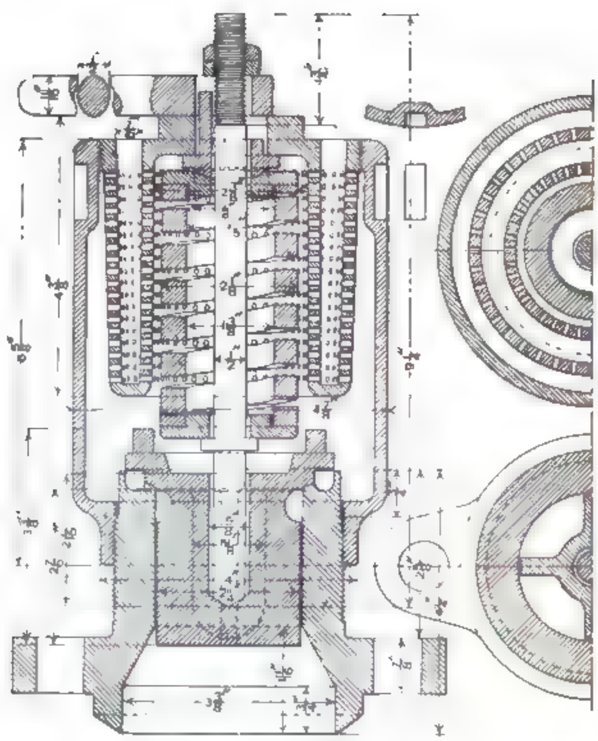
HORIZONTAL DRILLING ATTACHMENT.



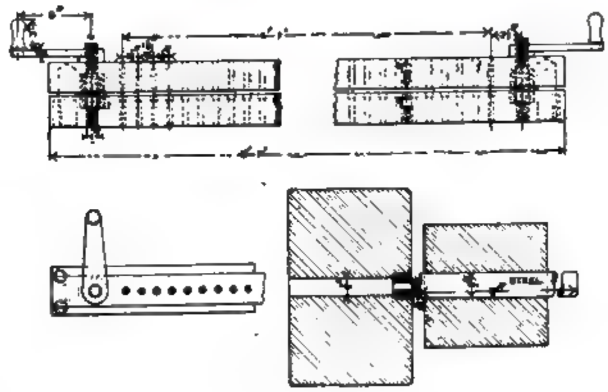
ONE TON TRAVELLING CRANE.



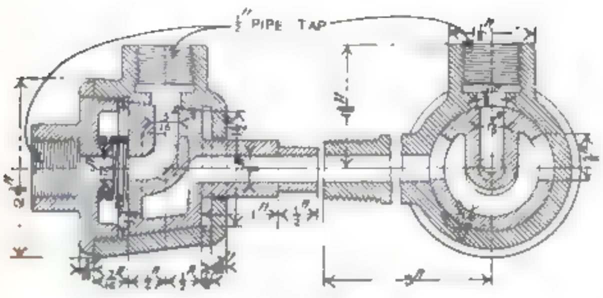
PNEUMATIC HOIST



MUFFLED POP SAFETY VALVE.



JACKET PUNCH.



VALVE FOR PNEUMATIC HOIST

SPECIAL TOOLS IN THE READING SHOPS OF THE PHILADELPHIA & READING RAILROAD.

three-way plug-valve. Air is admitted at the left-hand side of the vertical section, as shown, and comes immediately against the bottom of the valve, holding it up against its tapered side with the assistance of the small spring that is shown. The valve may be turned so as to admit air either to the bottom or the top of the cylinder, as may be desired. Of course when a load is on the hook no air need be admitted to the top of the cylinder for the purpose of lowering, but sometimes when it is up and no weight is attached the frictional resistance of the packing against the cylinder will be sufficient to hold it in that position unless some effort were exerted to force it down. The exhaust is led out through the center of the handle and blows into the atmosphere. It will be readily understood that when air has been admitted to the lower part of the cylinder it can be shut off and exhausted, and then air admitted to the upper end of the cylinder or to exhaust with perfect ease.

STANDARD MUFFLED POP-VALVE.

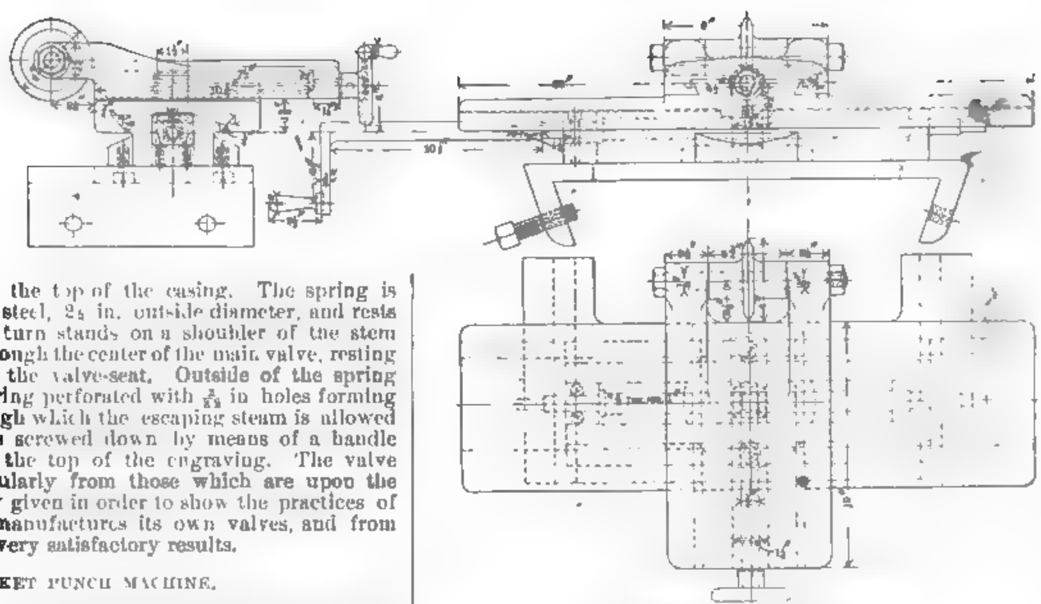
In our description of the Philadelphia & Reading shops, published in our issue for November, 1898, we gave a short memoranda of a small room which is set apart for the testing and the setting of the pop-valves used upon the locomotives. These valves are tested under steam pressure, and so adjusted that they will blow down about 4 lbs. The company own such a large number of locomotives that they have found it to be to their advantage to make their own valves rather than purchase them from manufacturers. The valve which they use is a combination pop and muffler, a vertical section of which we give in the accompanying engraving. It will be seen that it does not differ in essential particulars from the construction of the other pop-valves already upon the market. The main valve is of 4 in. diameter, with the wings extending well down into the body of the main casting, so that there is no danger of its being thrown out of alignment, while there is a play of $\frac{1}{32}$ in. between the wings and the casing. The seat of the valve is rounded instead of being straight, as it is frequently made. The groove outside of the valve-seat is turned to a gauge and is about $\frac{3}{8}$ in. deep from the top of the casing. The spring is made of $\frac{3}{8}$ in. square steel, $2\frac{5}{8}$ in. outside diameter, and rests upon a collar that in turn stands on a shoulder of the stem which comes down through the center of the main valve, resting upon it $1\frac{13}{16}$ in. below the valve-seat. Outside of the spring there is a U-shaped ring perforated with $\frac{3}{32}$ in holes forming the muffler, and through which the escaping steam is allowed to pass. The valve is screwed down by means of a handle and screw shown at the top of the engraving. The valve does not differ particularly from those which are upon the market, but is simply given in order to show the practices of one great road that manufactures its own valves, and from which it is obtaining very satisfactory results.

JACKET PUNCH MACHINE.

Every sheet-iron worker who has had to do with the placing of jackets on locomotive boilers knows the difficulty which he experiences and the time which it occupies in punching the necessary rivet holes. The little tool which we illustrate is one designed at the Reading shops for punching a large number of these holes at one and the same time. The large engraving at the lower right-hand corner shows the shape of the punch and dies. The punch is $\frac{3}{4}$ in. in diameter, and enters a steel die which is let into the frame below. The machine consists of two bars, with a number of these punches and dies arranged at intervals of $1\frac{1}{4}$ in. apart from center to center, and which are brought together by screwing down on the handles operating the nuts at either end of the machine. When the machine is screwed down in this way all of the holes are punched exactly in line and at the proper spacing apart. Turning back the handles slackens off the pressure on the back of the upper portion of the frame and it is thrown up, thus disengaging the punches by means of the springs, which are placed about the stem of the screw.

GRINDSTONE-TRUING DEVICE.

Every shopman where the grindstone is used for sharpening tools or for other purposes knows the disadvantages which accrue from its use, and the terrible dust which is usually raised by the ordinary apprentice truing down a grindstone after it has been worn out of shape by repeated grindings. It is a piece of work which must necessarily be done, and the dust which it creates is such as to be not only stifling to the workmen in the immediate vicinity, but decidedly injurious to all bearings and working parts of machinery with which it comes in contact. The device which we illustrate is a very simple affair, and can be readily made in any shape. It consists of a bed-piece of cast iron, which may be fastened to the frame of the grindstone by set screws, and on this bed-piece there is a transverse sliding carriage operated by a screw like an ordinary lathe. This carries a second carriage operated in the same way, the latter carrying a chilled wheel revolving on an arbor at its front side. The operation and the method of doing the work will be very readily understood. The bed-piece is clamped in position and the lower carriage run so that the chilled piece is opposite that portion of the wheel which is running the highest. The screw of the upper carriage forces this chilled wheel down against the grindstone and cuts away any projection which may exist there, and by working it backward and forward as the stone is cut away, it is a very short piece of work to remove all of the excrescences which have been raised by the tool grinding, and bring it back to a condition of roundness that is so desirable for this class of tool. The apparatus may be left clamped in position and the stone trued up every day, or as often as it may be desired to keep it in perfect condition; and where such a device as this is available and can be used at a moment's notice, it is probable that the wheel will be kept in perfect shape; but where we depend upon the iron bar and the apprentice attachment, the probabilities are that the stone will be allowed to become so badly out of true that it will be impossible to use it before any steps will be taken to bring it back into shape.



GRINDSTONE TRUING DEVICE.

THE KINGSLAND SHOPS OF THE DELAWARE, LACKAWANNA & WESTERN RAILROAD COMPANY.

We believe it is about a year ago that the Kingsland shops of the Delaware, Lackawanna & Western Railroad Company were destroyed by fire. They were immediately rebuilt, but, of course, many of the older tools and special appliances, which had been designed in the shop for particular pieces of work, were destroyed, and as there is no record left of them they have not been replaced. Therefore there is little about the shops to attract especial attention on the ground of its novelty. There are, we believe, 162 engines to be taken care of, and the floor space and pits available for the work render it necessary that every inch should be utilized to the utmost of its capacity, and even then it is difficult to get out the work as it is required. It is probable that before long the shops will be enlarged and more pits added. However, there are a few little wrinkles about the shop which are of interest and may be worth imitating by others.

The squaring machine for driving-wheels is utilized for turning off crank-pins while in position in the wheels. This is done by clamping the wheels on the centers and in position in the ordinary way, and then instead of the boring bar, which is used for boring them out, an attachment is put on with an overhanging tool that is driven by an independent belt and which turns off the crank-pins, so that the centers are accurately located the proper distance from the driving center. It is, of course, necessary to treat both wheels in this same way, but it has been found that the work is very satisfactory, and the pins can be turned off smooth enough for immediate use, and far more rapidly than it would be possible to remove them and true them up in a lathe for reinsertion. The tires are all shrunk upon and taken off from the driver centers by the use of the Wells light. In our issue for March, 1893, we published a description of the apparatus with which the Wells light is adapted for this purpose. The time which was required in the test reported at that time was 14½ minutes for each tire, but when this was done the workmen were not skilled in the handling of the apparatus, and it was evident to the spectators that a more rapid handling would be accomplished when a better drilled corps had charge of the work. This is the case, and it now only requires from 10 to 12 minutes to heat a tire and remove it.

The old method of using an injector for testing the boiler is in use here. An injector is attached to the boiler in the ordinary way, and forces the water in until the requisite pressure has been obtained.

There is a peculiar wrinkle, at least it is peculiar to us, in regard to the manufacture of piston-rods, that is giving very good satisfaction. Instead of having the rod hammered out and then turned off in the ordinary manner, the rod is hammered, and while it is still hot is given a three quarter twist from end to end. This seems to so interlace the fibers of the metal, that after it is turned off it possesses a greater strength than when it is left in the condition that usually obtains when it comes from the hammer direct. We do not know that this method is used in other shops, but it is considered in Kingsland to be a very great and desirable improvement in the manufacture of piston-rods.

The standard piston-head in use is solid with the rings sprung over and a couple of small holes drilled underneath for admitting the steam pressure beneath the rings that is required. Two cast-iron rings are used, and these are turned off slightly larger than the cylinder, sprung over the head and then sprung down so as to enter the cylinder.

The exhaust nozzles that are used are 4 in. in diameter, which gives a very even exhaust. They are single and the partition extends well up, so that there is no possibility of the exhaust passing over from one cylinder to the other and causing an undue back pressure.

Every master mechanic has experienced more or less difficulty with breaking of rod-straps that have been designed too small for the service which they are called upon to render. This difficulty has been obviated on a number of engines in the Kingsland shops, by widening out the rod-straps on the front end of the connecting-rod. There is really no necessity for any flanges here, as the box is held securely in position by the sides of the cross head when the strap is widened out, until it comes in contact with the cross-head and is held in position laterally. By widening it out a very large percentage of increased strength is added, and where this has been done all trouble from broken straps has entirely disappeared. It is nothing more than would suggest itself to any one, and yet there are some who are so firmly convinced that a flange on the brass is necessary, that they will hesitate to widen the strap. It is a parallel case with the collarless crank-pins, which came into use some time ago on the main driving-wheels. The box of the side rods and the main rods coming together hold each other firmly in position, and there is no use for a collar on the crank-pin, except to weaken the same and make work in the shop.

Some months ago there was a discussion at the New York Railroad Club regarding the broken mogul frames, and very little information was elicited as to their causes. The nearest approach to actual statement of the case being that the frames were not strong enough for the work. Some time after the meeting we saw some mogul frames in which the fillets on the inside of the pedestals were not more than three-quarters of an inch in radius, and these engines were giving a great deal of trouble by breaking through at this point, clearly proving the efficiency and necessity of a good large fillet. While these engines did not belong to the Delaware, Lackawanna & Western Road, and although all the engines there had large and substantial fillets, it has been found that it is very greatly to the advantage of the engine to have the end boxes of the mogul engines keyed up rather loosely and the main boxes tightly. This allows for a little longitudinal motion as well as a free, lateral play on rounding curves, and takes the strain off from the frames by allowing the wheels to adjust themselves to the track in a proper and natural way. The Company casts their own brasses, and uses a composition of five and one-half of copper to one of tin. The cast-steel driver-boxes have brass liners of this metal. Of course in a shop which has been so recently rebuilt there are a number of very fine machine tools which are doing admirable work. Among others there is a quick return Sellers planer of the latest design that reminds one more of the quick gig of a saw-mill carriage than anything else we have ever seen in the way of a machine tool. The forward motion on this planer is about 25 ft. per minute, but the return motion is, we believe, about 125 ft.

PROGRESS IN FLYING MACHINES.

By O. Chanute, C.E.

(*Concluded from page 583, Volume LXVII.*)

The general problem having been thus decomposed into its several elements, and each element considered as a separate problem, it will be seen that the mechanical difficulties are very great; but it will be discerned also that none of them can now be said to be insuperable, and that material progress has recently been achieved toward their solution.

The resistance and supporting power of air are approximately known, the motor and the propelling instrument are probably sufficiently worked out to make a beginning; we know in a general way the kind of apparatus to adopt, its approximate extent and required texture of sustaining surfaces, and there remain to solve the problems of the maintenance of the equilibrium, the guidance, the starting up, and the alighting, as well as the final combination of these several solutions into one homogeneous design.

In spite, therefore, of the continued failures herein recorded, it is my own judgment, as the result of this investigation into the "progress in flying machines," more particularly the progress of late years, and into the recent studies of the principles and problems which are involved, that, once the problem of equilibrium is solved, man may hope to navigate the air, and that this will probably be accomplished (perhaps at no very distant day), with some form of aeroplane provided with fixed concavo-convex surfaces, which will at first utilize the wind as a motive power, and eventually be provided with an artificial motor.

The conclusion that important progress may be achieved without an artificial motor was little expected when this investigation was begun; but the study of the various experiments which have been passed in review, the perception of the partial successes which have been accomplished with soaring devices, and the general consideration of the subject, have led to the conclusion that the first problem which it is needful to solve is that of the equilibrium, and that in working this out the wind may furnish an adequate motive power.

Preliminary experiments will, of course, be tried upon a small scale, but no experiment with a model can be deemed quite conclusive until the same principles have been extended to a full-sized apparatus capable of sustaining a man, and until this has been exposed to all the vicissitudes of actual flight. It will readily be discerned that a less achievement than this would not prove an adequate performance, and that no matter how well a model might behave in still air, there would still remain the questions as to how it would behave in a wind, and how it was to solve the problems of starting up and of alighting.

It would seem, therefore, that the first problem to solve is that of the maintenance of the equilibrium at all the angles of incidence required; in rising, in sailing, in encountering wind eddies, and in alighting.

For this purpose, it is now my opinion, based upon the performance of the soaring birds and upon the partial success of some soaring devices, that the problem of equilibrium can best be solved with an apparatus which shall utilize the wind as a motive power—*i.e.*, with some form of aeroplane of sufficient size to sustain a man, with which the operator shall endeavor to perform the various manœuvres required to meet the varying conditions of actual flight, and to preserve at all times his balance in the air. In other words, a flying machine to be successful must be at all times under intelligent control, and the skill to obtain that control may be acquired by utilizing the impulse of the wind, thus eliminating, for a time at least, the further complications incident to a motor.

But whether a soaring device be first experimented with, or whether the initial apparatus be provided with a motor, the next question pertains to the conditions under which a machine carrying a man can be experimented with most safely.

Various methods have been suggested, and a few have been tried. The most obvious is to suspend the apparatus from a cable stretched between two tall masts or between two steep hills. This has been proposed many times, but we have seen by the experience of M. *Sanderval* that it does not afford sufficient length of suspending rope to permit of unimpeded manœuvres, and that experience gained in that way would scarcely be available in free flight. A preferable plan has been proposed by M. *Duryea* (and probably by others), which consists in suspending the apparatus to be experimented with from a captive balloon, anchored by several divergent ropes so as to remain a half mile or thereabouts from the ground, as shown in fig. 88. By means of a rope passing through a pulley block attached to the balloon, and thence to a windlass on the ground, the machine to be experimented with may be drawn into the air to a sufficient height to clear the gusty air conditions found at or near the ground, and there, in comparative safety, the sky-cycler might manipulate his devices, ascertain the effect of various manœuvres, and gradually gain control, skill, and confidence preparatory to trusting himself to actual flight.

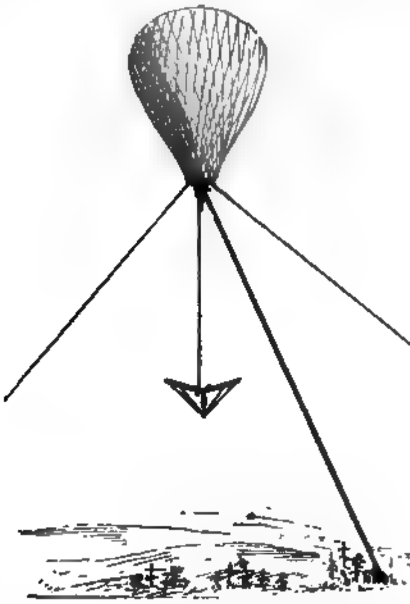


FIG. 88.—DURYEA'S PROPOSAL—1896.

This method is understood to have been employed by M. *C. E. Myers*, the aeronautical engineer, in experimenting with parachutes, and to have given promise of satisfactory results within certain limits. It is well worth testing as a preliminary trial of a flying apparatus, but it should be remembered that a machine suspended from a rope, however long, will not be under quite the same circumstances as in free flight. Even if it rises upon the wind and is wholly supported thereon it will still be hampered by the rope, and perhaps restrained from some action which it is important to understand in order to maintain the equilibrium, so that the operator will never be quite certain that he has gained complete control over his apparatus.

Other methods have been proposed by various writers. M. *Ch. Weyher*, for instance, in the *Aéronaute* for July, 1884, suggested the construction of a circular railway of 600 to 1,000 ft. diameter, upon which a large platform car, covered with a soft mattress, should carry the apparatus to be tested, attached with restraining ropes about breast high. This car to be towed at varying speeds by a locomotive, so as to afford a sustaining effect and to encounter the wind at various angles, until the operator shall master the necessary manœuvres.

M. *A. Goupil*, on the other hand, proposes a circular elevated railway consisting of a single central girder suspended by wire ropes between two rows of posts, and serving to carry a truck to which the apparatus to be experimented with may be suspended. In this case the machine might be provided with its own motive power, or towed by a wire rope, or driven by an electric motor, but in either case there would still remain the restraint of the safety suspending rope, which, as previously suggested, might vitiate the various air reactions which it is important for the operator to experience practically.

These, and other devices which may be suggested, may doubtless prove useful in making the preliminary trials with various forms of apparatus, thus testing their behavior when restrained, but there will always come a time when such apparatus, if apparently adequate, must be tried at full liberty and encounter all the contingencies of free flight. It seems clear that after the preliminary trials with models have been made, time may be saved in ascertaining the full merits of a device and in improving it, if experiments with the full-size apparatus be made at entire liberty instead of under restraint, provided adequate precautions be taken to avoid serious injury in alighting.

Referring to the various experiments which have been made with full-sized apparatus, more particularly those of *Dante*, *Le Bris*, *Mouillard*, *Lilienthal*, and *Montgomery*, it is seen that *Dante* adopted the more rational plan of all by experimenting over a sheet of water, although the exact method he pursued is not known.

Upon the whole, the best mode of procedure is probably that proposed by *Le Bris*, which want of means prevented him from adopting—that is to say, to start from the deck of a steam vessel under way, so as to obtain initial velocity, as well as to face the wind from whatever direction it may blow, and to be quickly picked up after alighting. If the machine be provided with a light buoy and line, and the operator be encased in a cork jacket or life-preserver, he may thus quickly put to the test the merits and the deficiencies of his apparatus with but little danger to himself, and ascertain whether it can be brought under control. The machine may experience breakages, the operator will doubtless suffer many duckings, he may even be stunned at times, but he is not likely to lose his life or to break a limb, as he might do were he to experiment over land.

It is believed that salt water is preferable to fresh water, over which to carry on such experiments, not only because of the greater buoyant power of the water, but especially because sea breezes are more regular and less gusty than land breezes. It is evident that it would be preferable to operate over a genial or a tepid sea, in trade-wind regions if possible, and in locations where steady sea breezes of no great intensity may be relied upon to blow almost daily. It would be desirable to select the vicinity of some projecting tongue of land or of some isthmus, where captive preliminary tests may be made, and also that there should be a cliff in the neighborhood whence models and perhaps the apparatus itself might be floated off. There are many such spots to be found within proximity of machine shops, in the Mediterranean, in the Gulf of Mexico, and on the coast of Southern California, and the attention of designers of flying machines, who may want to test the merits of their devices upon a really adequate scale, is particularly directed to the vicinity of San Diego, Cal., where all the circumstances which have been alluded to are to be found combined, even to a local railroad along the beach, on which the tests proposed by M. *Weyher* might be carried on.

All this presupposes that the preliminary experiments with small models have resulted satisfactorily, and that the designer wishes further to test the merits of his apparatus upon a practical working scale, with a machine capable of carrying a man and provided with the requisite devices to bring it under control while in the air, and thus to work out the problem of equilibrium. The expense will doubtless be considerable, and the mishaps not infrequent, but there seems to be no surer way of ascertaining whether a full-sized apparatus will preserve its balance in the air, while the risk of serious injury will be small. If such experiments finally succeed in solving the equilibrium problem, in securing safety in rising, in sailing, and in coming down, with a machine carrying its operator, an immense step forward will have been taken toward solving the other problems mentioned, and toward finally developing a safe flying machine, provided with a motor of its own and capable of being operated anywhere; for once safety has been secured under the various actual conditions of outdoor performance, it ought to be a comparatively easy and short task to work out the other questions, save perhaps those pertaining to the starting up from and alighting upon the ground.

Assuming all this to be possible—and while the mechanical difficulties are doubtless great, they do not seem to be insuperable—the final working out of the general problem is likely to take place through a process of evolution. The first apparatus to achieve a notable success will necessarily be somewhat crude and imperfect. It will probably need to be modified, reconstructed, and readventured many times before it is developed into practical shape. The invent-

or will doubtless have to construct the first models and perhaps the first full-sized machine at his own expense, in order to demonstrate the soundness of his conception and the comparative safety of its operation; but after this much is accomplished further remodelling and experiment will still probably be required to develop the apparatus into commercial value.

This phase of the evolution is likely to require the aid of capital, because the expense may be quite considerable: and inasmuch as a financial venture to develop such a difficult and novel contrivance must be gone into as a hazard, with the acceptance of the possibility of total loss as an offset for the hope of drawing a prize, the parties advancing the capital will probably require that the invention (if invention there be) shall be fully protected by patents.

In view of this probable requirement, it may be questioned whether M. *Hargrave* is quite prudent in taking out no patents for his various devices, for he hints in his last paper that he is hampered in his experiments by having to perform them in public. The difficulty arises from the fact that the experiments, to be of practical value, have to be performed out of doors, and the writer knows of some designers who, unable, on the one hand, to secure a patent—in the United States at least—until they can demonstrate the practical performance which they hope for, and apprehensive, on the other hand, of being annoyed by spectators, have retired into a wilderness to make their experiments, thus placing themselves at serious disadvantage in case a mishap of any kind occurs.

Most of the patents heretofore granted for flying machines are quite impracticable, yet the claims cover, here and there, some feature which may eventually contribute to success. It will be judicious, therefore, for designers of projected flying machines to study prior patents, and an attempt has been made in these pages to indicate some of those which contain valuable suggestions. The novelty (if any) in future patents will probably largely consist in new combinations of features already patented.

There are probably a good many arrangements of sustaining surfaces which will prove available for aeroplanes; some will prove more effective and steadier than others, and this must be ascertained by experiment; but in any event success would be hastened by a working association of experimenters in this inchoate research, for the problems, as has been seen, are many, and no inventor is likely to be in possession of all the miscellaneous knowledge and variety of talent required to perfect so novel an undertaking.

To the possible inquiry as to the probable character of a successful flying machine, the writer would answer that in his judgment two types of such machines may eventually be evolved: one, which may be termed the soaring type, and which will carry but a single operator, and another, likely to be developed somewhat later, which may be termed the journeying type, to carry several passengers, and to be provided with a motor.

The soaring type may or may not be provided with a motor of its own. If it has one this must be a very simple machine, probably capable of exerting power for a short time only, in order to meet emergencies, particularly in starting up and in alighting. For most of the time this type will have to rely upon the power of the wind, just as the soaring birds do, and whoever has observed such birds will appreciate how continuously they can remain in the air with no visible exertion. The utility of artificial machines availing of the same mechanical principles as the soaring birds will principally be confined to those regions in which the wind blows with such regularity, such force, and such frequency as to allow of almost daily use. These are the sub tropical and the trade-wind regions, and the best conditions are generally found in the vicinity of mountains or of the sea

This is the type of machine which experimenters with soaring devices heretofore mentioned have been endeavoring to work out. If unprovided with a motor, an apparatus for one man need not weigh more than 40 or 50 lbs., nor cost more than twice as much as a first-class bicycle Such machines therefore are likely to serve for sport and for reaching otherwise inaccessible places, rather than as a means of regular travel, although it is not impossible that in trade-wind latitudes extended journeys and explorations may be accomplished with them; but if we are to judge by the performance of the soaring birds, the average speeds are not likely to be more than 20 to 30 miles per hour.

The other, or journeying type of flying machines, must invariably be provided with a powerful and light motor, but they will also utilize the wind at times. They will probably be as small as the character of the intended journey will admit of, for inasmuch as the weights will increase as the cube of the dimensions, while the sustaining power only grows as the square of those dimensions, the larger the machine the greater the difficulties of light construction and of safe operation. It seems probable, therefore, that such machines will seldom be built to carry more than from three to 10 passengers, and will never compete for heavy freights, for the useful weights, those carried in addition to the weight of the machine itself, will be very small in proportion to the power required. Thus M. *Maxim* provides his colossal aeroplane (5,500 sq. ft. of surface) with 300 H.P., and he hopes that it will sustain an aggregate of 7 tons, about one-half of which consists in its own dead weight, while the same H.P., applied to existing modes of transportation, would easily impel—at lesser speed, it is true—from 350 to 700 tons of weight either by rail or by water.

Although it by no means follows that the aggregate cost of transportation through the air will be in proportion to the power required, the latter being but a portion of the expense, it does not now seem probable that flying machines will ever compete economically with existing modes of transportation. It is premature, in advance of any positive success, to speculate upon the possible commercial uses and value of such a novel mode of transit, but we can already discern that its utility will spring from its possible high speeds, and from its giving access to otherwise unreachable points.

It seems to the writer quite certain that flying machines can never carry even light and valuable freights at anything like the present rates of water or land transportation, so that those who may apprehend that such machines will, when successful, abolish frontiers and tariffs are probably mistaken. Neither are passengers likely to be carried with the cheapness and regularity of railways, for although the wind may be utilized at times and thus reduce the cost, it will introduce uncertainty in the time required for a journey. If the wind be favorable, a trip may be made very quickly; but if it be adverse, the journey may be slow or even impracticable.

The actual speeds through the air will probably be great. It seems not unreasonable to expect that they will be 40 to 60 miles per hour soon after success is accomplished with machines provided with motors, and eventually perhaps from 100 to 150 miles per hour. Almost every element of the problem seems to favor high speeds, and, as repeatedly pointed out, high speeds will be (within certain limits) more economical than moderate speeds. This will eventually afford an extended range of journey—not at first probably, because of the limited amount of specially prepared fuel which can be carried, but later on if the weight of motors is still further reduced. Of course in civilized regions the supply of fuel can easily be replenished, but in crossing seas or in explorations there will be no such resource.

It seems difficult, therefore, to forecast in advance the commercial results of a successful evolution of a flying machine. Nor is this necessary; for we may be sure that such an untrammelled mode of transit will develop a usefulness of its own, differing from and supplementing the existing modes of transportation. It certainly must advance civilization in many ways, through the resulting access to all portions of the earth, and through the rapid communications which it will afford.

It has been suggested that the first practical application of a successful flying machine would be to the art of war, and this is possibly true; but the results may be far different from those which are generally conjectured. In the opinion of the writer such machines are not likely to prove efficient in attacks upon hostile ships and fortifications. They cannot be relied upon to drop explosives with any accuracy, because the speed will be too great for effective aim when the exact distance and height from the object to be hit cannot be accurately known. Any one who may have attempted to shoot at a mark from a rapidly moving railway train will probably appreciate how uncertain the shot must be.

For reconnoitring the enemy's positions and for quickly conveying information such machines will undoubtedly be of great use, but they will be very vulnerable when attacked with similar machines, and when injured they may quickly crash down to disaster. There is little question, however, that they may add greatly to the horrors of battle by the promiscuous dropping of explosives from overhead, although their limited capacity to carry weight will not enable them to take up a large quantity, nor to employ any heavy guns with which to secure better aim.

Upon the whole, the writer is glad to believe that when man succeeds in flying through the air the ultimate effect will be to diminish greatly the frequency of wars and to substitute some more rational methods of settling international misunderstandings. This may come to pass not only because of the additional horrors which will result in battle, but because no part of the field will be safe, no matter how distant from the actual scene of conflict. The effect must be to produce great

uncertainty as to the results of manœuvres or of superior forces, by the removal of that comparative immunity from danger which is necessary to enable the commanding officers to carry out their plans, for a chance explosive dropped from a flying machine may destroy the chiefs, disorganize the plans, and bring confusion to the stronger or more skillfully led side. This uncertainty as to results must render nations and authorities still more unwilling to enter into contests than they are now, and perhaps in time make wars of extremely rare occurrence.

So may it be; let us hope that the advent of a successful flying machine, now only dimly foreseen and nevertheless thought to be possible, will bring nothing but good into the world; that it shall abridge distance, make all parts of the globe accessible, bring men into closer relation with each other, advance civilization, and hasten the promised era in which there shall be nothing but peace and good-will among all men.

THE END.

THE DRIGGS-SCHROEDER RAPID-FIRE GUNS.

The Driggs-Schroeder rapid-fire gun, of which we give illustrations, is one of the number that is to be tested by the Ordnance Department of the United States Army, at Sandy Hook, as soon as the preparations for the trial can be completed. It has undergone the tests of the Navy Department, and has been accepted by it and placed upon several of the vessels in the Navy. Among others there are eight of these guns on the cruiser *New York*. The rapid-fire guns have been developed as a necessary result of the fleets of fast torpedo boats, which cause the naval officials of the world to recognize the fact that the best defense against their attack lay in a great volume of fire, which could best be obtained by increasing the number of small guns on board ship, and giving each one great rapidity of fire and accuracy of aim The introduction of the metallic casing for the ammunition with the breech-operating mechanism, which reduces the time required to eject, load, and cock to the minimum, affords the best solution of the problem. In connection with this it was also necessary that the gun should be freely movable about a center pivot, and that the gunner should be protected against the effects of the recoil. These are the particular features of the rapid fire gun as they have been developed at the present time. Although some of these guns are mounted without a recoil, it has been found expedient and feasible to use mounts which allow of a slight recoil in the line of fire in connection with automatic return to battery. When this is done the stock is attached to the rigid portion of the mount. Advantage is taken of the power of the recoil and counter-recoil to utilize it in assisting in some of the operations of the service of the gun, such as opening, ejecting, and cocking by the counter-recoil. Thus the difference in time between an aimed and an unaimed shot is reduced simply to the time occupied in pointing, and the only operations in which the rates of fire are usually compared are those of extracting and loading.

For a number of years the rapid-fire principle was only applied to guns throwing projectiles weighing 6 lbs. or less, but as their powers were increased and the quality of the ammunition improved, they have been expanded so as to embrace calibers up to 6 in.

The breech mechanism of the Driggs-Schroeder system is shown in the engraving giving the longitudinal vertical section. The top of the breech is protected and there is no opening through which rain or dirt can enter, and even when the breech is open the block and entire mechanism remain within the curtain and are completely protected. The block is very light, and thus promotes rapidity of fire. The gain in power is due to the increased travel of the shot, and is not accompanied by any sensible increase in the violence of the recoil. There are also double independent extractors. The gun can be readily placed at half-cock, and the device for automatically ejecting the empty cartridge case is readily worked.

Our illustrations of the profile and longitudinal sections of the gun show its general construction very clearly. The hoop, which is the first piece to be shrunk on the tube, is expanded by heat and slipped on from the muzzle end until the shoulder on its interior is close against a corresponding shoulder on the tube, and it is firmly held in this position until it is cold. The jacket is then put on in like manner from the breech end. This method insures perfect contact at the shoulders between the tube and hoop. On the exterior of the gun a screw-thread is cut, part of which is on the hoop and part on the jacket, and the trunnion band is screwed over it for non-recoil mountings and the saddle for recoil mountings. Thus the entire system is locked together, and all longitudinal motion between the tube and jacket or hoop is prevented. The metal used is the best quality of open-hearth steel furnished by the Midvale Steel Company and the Bethlehem Iron Company. Test pieces 2¼ in. long × ¼ in. diameter are cut from each forging, and when broken they must show the steel to possess the following characteristics: Ultimate tensile strength, 90,000 to 135,000 lbs. per square inch; elastic strength, 50,000 to 80,000 lbs. per square inch; elongation after rupture, 15 to 30 per cent. in its length in 2 in.; contraction, 20 to 50 per cent. of the original area. For the breech-blocks the specifications are made still higher, a tensile strength being required of not less than 130,000 lbs., and an elastic strength of not less than 70,000 lbs. per square inch. If the figures of any piece fall below these the forging is rejected. The forgings are all tempered and annealed, the last process being always an annealing one to relieve the internal strains of the mechanism.

In determining the gun profiles careful study has been given to the subject of slow-burning powders, the adoption of which modifies the pressure curves, and while the maximum pressure is lost, it is sustained for a much greater distance along the bore. To provide for this, the strength at the bottom of the chamber is made equal to what was necessary with quicker powders, but from the front end of the hoop to the muzzle it has been much increased.

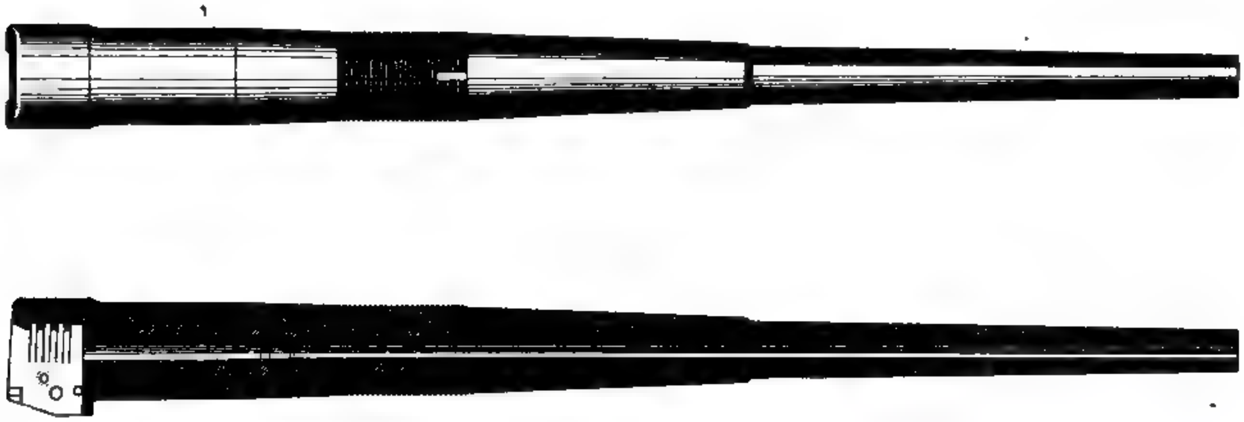
The action of the breech mechanism is very simple, as it contains no delicate parts and is not easily put out of order. The fact of the block and all of its working parts being symmetrical makes it easily understood from the drawings. Passing through the breech from one curtain to another and below the bore of the gun is the main bolt *B*, about which the block turns back. The transverse hole through the block for this main bolt *B* is lengthened in a nearly vertical direction, as shown by the dotted lines, to permit the block to descend and disengage the points from the corresponding grooves in the breech. The main cam *C*, which is shown in solid line about the hub encircling the bolt *B*, has its bearing on this bolt, and, as will be seen from the engraving, its front upper face comes to a bearing under the interior surface of the block and holds it in the upper or closed position. The back surface inclines upward to the rear, and when the cam is turned to the rear for opening, this permits the block to descend, the lower rear corner of the cam coming to a bearing on the interior bottom surface, shown by the hatched lines, and forcing it down. On the other hand, in the latter part of the closing motions the upper front surface comes in contact with the under part of the incline, just back of the point where it bears in its final position and pushes the block up into place, and then after slightly passing the center of rotation it comes under the curved surface, so that in this position the downward thrust of the block has no tendency to turn backward, and it is therefore held securely in place.

When the main cam has been turned and the block pushed down sufficiently far to clear the bands from the grooves, the semi circular score in the upper rear corner engages the pin *L* in the block, and from that time on the movement of the two are in unison, and the block is rotated backward about the main bolt until its rear face finally rests upon the tray *T*, leaving the chamber wide open.

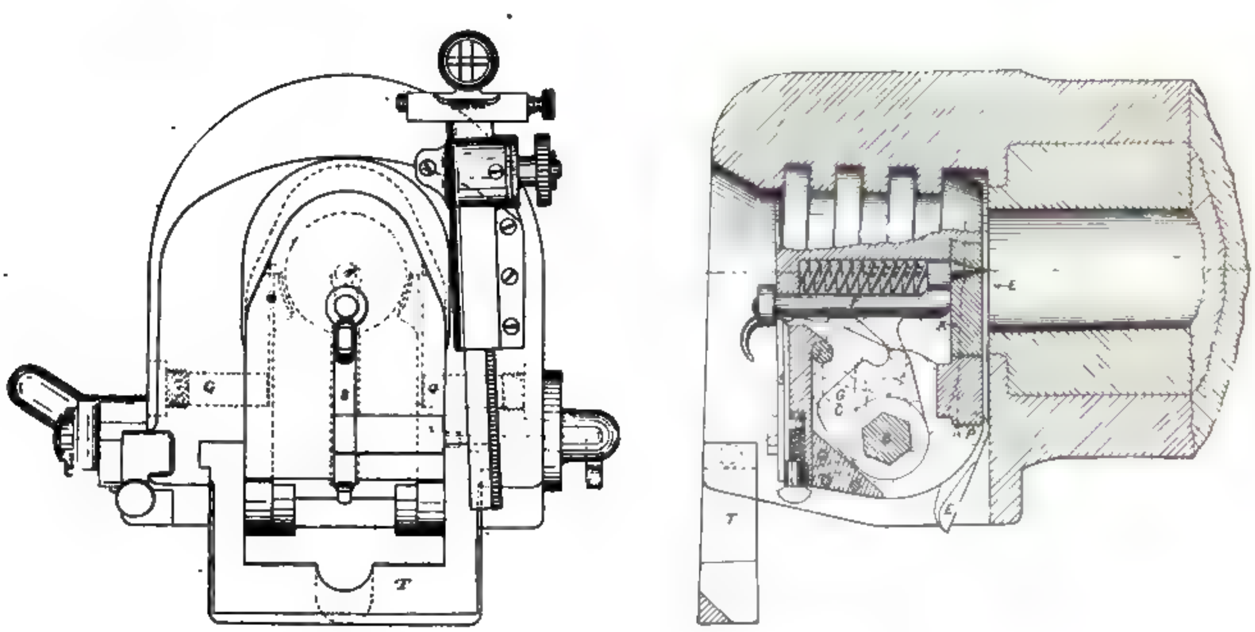
The firing-pin is marked *F*, and its spring lies to the rear of its upturned head, as shown. The full cock and half cock studs are, it will be seen, under the rear part; the sear *S*, which is actuated by a spring at the bottom of the block, presses it up against and engages the studs in succession as the firing-pin is forced to the rear. The point of a lug, projecting from the under side of a firing-pin, always rests in a circular groove hollowed out in a vertical plane in the upper surface of the main cam. When the cam is turned to the rear it first pushes back that lug and the firing-pin, so that the point of the latter is brought safely within the face of the block before it begins to descend. This motion continues, and the firing-pin is drawn back until the full-cock stud passes beyond the sear and is engaged by it. This compresses the firing-spring. When the sear is pressed down the firing-spring is released and the spring impels it forward. The finger catch, screwed on to the rear end, may also be used to retract or full cock the firing-pin without opening the breech.

motion is slow at the first, with a powerful leverage toward the latter part of the rotation of the block the motion imparted is quick.

It will be remembered that the block has a certain amount of vertical motion with regard to the main bolt, and must be kept in the lower position relatively to it during the rotation. For this purpose a guide-bolt, *G*, is screwed in through each side of the curtain, projecting into the guide-groove and on each side of the block. This groove is so shaped that the bolt permits only the vertical and rotary motions of the block in succession. It also has another function to perform in closing the breech after the rotary motion of the block changes to the vertical motion that is produced by the upper corner of the cam pressing on the interior inclined surface of the block. For the purpose of easing the change of motion from rotary to vertical, the part of the groove where the guide-bolt is at that instant is cammed, so as to make the bolt start the block upward before the corner of the main cam touches the incline.



PROFILE AND LONGITUDINAL SECTION OF THE DRIGGS-SCHROEDER RAPID-FIRE GUN.



REAR ELEVATION AND LONGITUDINAL SECTION OF BREECH BLOCK OF THE DRIGGS-SCHROEDER RAPID-FIRE GUN.

The extractors *E* are located one on each side, and lie flat against the rear face of the tube of the gun and in rests in the front face of the block. They revolve on pivots *P*, which work in rests in the curtain. The rear sides of these extractors form cam surfaces. The lower front corners of the block are similarly surfaced, and the grooves are slightly eccentric to the main bolt, so that after the block has been lowered and during its rotation its cam surfaces press against the extractor tools, pressing them forward and consequently bringing the extractor and heads to the rear and throwing the cartridge case out. These bearing surfaces are so adjusted that the motion of rotation thus merges gradually and easily into that of vertical translation.

The bands on the top and side of the block and the corresponding grooves in the breech are inclined about 2° 30′ to the front and upward, so that as the block is pushed up into position in closing it is also pressed forward and presses the cartridge case home, and in opening it readily detaches itself from the head of the case.

There is a spring-lock on the handle which, when the breech is closed, prevents the main bolt and block from moving under stress of any kind, except that applied directly to the

handle. The snap connected with this indicates by the sound when the block is in place and locked.

The sear, which slides vertically in the middle of the rear face of the block, has an arm extending to the side with a finger at the end, which is pressed downward by a toe on a rock shaft connected with the pistol-grip and trigger, or by the firing-lanyard. When the trigger is used with recoil mounts it is placed under the stock; as the latter attaches to the stationary part of the mount there is no shock given to the hand of the firer by the recoil; the finger of the sear is in rear of the toe of the trigger, and leaves it during the recoil, being brought back in contact as the piece returns to battery. In the design adopted for the United States Navy, with a pistol-handle on the shoulder-bar, the trigger in the handle is connected directly with the sear by a chain-lanyard.

To facilitate assembling the front face of the block contains a heavy face plate, *K*, easily removed and secured; the cam and firing-pin and spring are removed and replaced there.

It must not be understood from this description that when the block is in position any strain whatever comes upon the main bolt. The bands extend well around on the side and sustain the whole force of the discharge without putting any strain whatever upon the bolt.

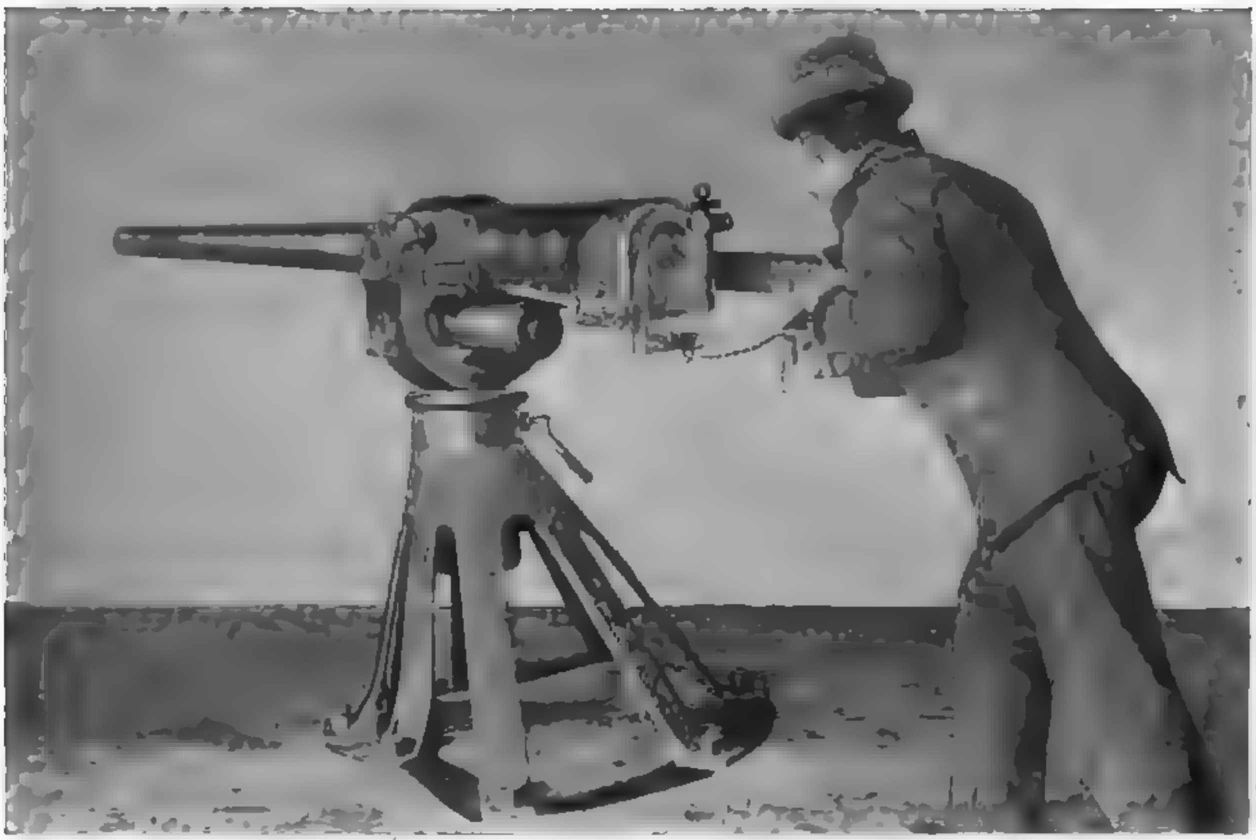
The refilling is an increasing twist on a curve connecting the initial and final angles of a semi-cubical parabola. The sights are capable of rapid changing of setting with but one hand. The rear sight has double cross wires and the front sight single wires. The advantage of this arrangement is that the gun can be pointed almost as accurately as with a telescopic sight and that there is a clear field about the trigger. The cross-bar of the sights is graduated in spacing representing 10 minutes of a horizontal arc. This has been done mainly to assist the officers commanding the guns, who are able thereby to designate the amount the eye-piece is to be moved. The space on the sight-bar represents 100 yds. in range when using the service charge.

The gun is mounted on two general types—the recoil and non-recoil. The engraving which we present shows it on the recoil mounts, which is known as Fletcher hydraulic recoil mount. For this mount the trunnion band is dispensed with, and the gun is screwed into a gun-metal casting termed the saddle, having a single recoil cylinder in its main part. The cylinder contains the means for checking the recoil and returning the gun to the firing position. The recoil is checked by regulating the flow of the liquid, which is usually glycerine and water, from one side of the piston to the other. This is accomplished by forming depressions or ports in the interior surface of the cylinder. The area of the cross section of these ports varies in such a manner that, although the piston has a changing velocity, a constant pressure is maintained on the pistonhead. The return to the firing-piston is effected by means of a recoil-spring.

The guns are manufactured as 1-pdrs. high-power light, 3-pdrs., 6-pdrs., 12-pdrs., 9-pdrs., $3\frac{6}{10}$ in., 14 pdrs., and 33 pdrs.; 70 and 100-pdrs. have also been designed.

The gun's crew consists of three men: one has his shoulder against the stock, and does the aiming and firing; the second does the loading, and the third handles the ammunition and serves the second man.

In trials which have been made with the 6-pd. guns an initial velocity of 1,870 ft. per second has been obtained. Rapidity of the firing when the gun is used, regardless of aim, has been 35 shots per minute. In a future issue we expect to publish the details of the trial with this gun, that will be held under the supervision of the Ordnance Board at Sandy Hook.



6-POUNDER RAPID-FIRE DRIGGS-SCHROEDER GUN ON NAVAL MOUNT.

The following is the general data concerning the 6 pd. naval gun which we illustrate:

Weight of gun complete..............	783 lbs.
" " projectile..................	6 "
Muzzle velocity of projectile..........	1,870 f. s.
Range about..........................	$4\frac{1}{2}$ miles.
Rapidity of fire........	33 rounds per minute.
Thickness of steel plate perforated at 200 yds..........................	4 in.

The design of the gun is entirely American in every particular, and in this is different from any other rapid-fire gun in the Navy.

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

THE object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publication will in time indicate some of the causes of accidents of this kind, and help to lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with informa-

LOCOMOTIVE RETURNS FOR THE MONTH OF SEPTEMBER, 1893.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage. Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Av. Train. Passenger Cars.	Freight Cars.	Coal Burned per Mile. Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Cost per Locomotive Mile. Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Cost per Car Mile. Passenger.	Freight.	Cost of Coal per Ton.
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Atchison, Topeka & Santa Fé	832	747	....	....	....	2,006,155	2,686	....	....	....	....	....	78.41	....	....	3.56	6.63	0.16	0.10	6.70	1.38	18.53	....	....	1.61
Canadian Pacific	615	....	524,741	715,821	507,724	1,748,286	2,842	....	....	....	....	....	67.65	....	....	3.44	10.72	0.34	....	5.66	1.81	21.47	....	....	3 14
Chic., Burlington & Quincy	541	....	....	....	....	1,531,228	2,830	6.26	20.45	....	....	....	81.83	....	.	4.22	5.43	0.22	0.16	6.65	0.04	16.72	....	....	1.38
Chic., Milwaukee & St. Paul	857	....	....	....	....	2,568,119	2,996	....	....	....	....	....	68.00	....	....	3.15	7.08	0.27	....	6.78	....	17.23	....	....	2 40
Chic., Rock Island & Pacific	564	....	589,093	1,012,540	348,401	1,950,034	3,457	....	..	62.05	78.24	38.14	66.35	....	....	2.48	6.14	0.25	2.48	6.11	0.33	15.31	....	....	2.00
Chicago & Northwestern	....	....	854,744	1,369,944	647,775	2,871,463	....	....	....	....	....	....	84.42	....	....	2.83	7.91	0.33	....	6.31	0.77	18.15	....	....	1.85
Cincinnati Southern	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Cumberland & Penn.*	25	25	5,446	33,464	87,018	38,910	1,556	....	....	....	....	....	78.70	....	....	7.02	4.41	0.39	....	....	1.80	13.62	....	....	....
Delaware, Lackawanna & W. Main L.	211	183	....	....	....	628,630	3,408	....	....	....	....	....	85.61	....	....	3.18	6.44	0.45	.	5.91	....	....	....	....	....
Morris & Essex Division	160	....	180,698	141,883	87,018	409,599	2,559	....	....	....	....	....	64.24	....	....	3.83	10.00	0.39	....	6.52	....	20.75	....	....	3.07
Hannibal & St. Joseph	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Kansas City, F. S. & Memphis	149	....	93,233	181,231	79,623	354,087	2,411	....	....	....	....	....	61.72	....	....	3.19	5.17	0.37	0.41	7.34	....	16.48	....	....	1.62
Kan. City, Mem. & Birm	42	35	33,059	48,265	11,806	93,130	2,739	....	....	....	....	....	63.09	....	....	2.86	3.39	0.21	0.35	7.08	....	13.89	....	....	1.02
Kan. City, St. Jo. & Council Bluffs	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Lake Shore & Mich Southern	596	....	504,144	657,885	382,032	1,544,061	2,590	....	....	65.76	88.01	87.82	67.72	....	....	2.01	5.19	0.19	....	6.84	0.17	14.40	....	....	1.52
Louisville & Nashville	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Manhattan Elevated	....	269	681,599	....	62,394	748,993	2,765	....	....	....	....	....	88.98	....	....	2.10	7.80	0.20	....	9.50	....	19.60	....	....	3.99
Mexican Central	148	114	....	....	....	334,039	2,930	....	....	....	....	....	62.26	....	....	5.71	12.32	0.46	0.22	4.73	0.88	24.32	....	....	4.26
Mil., L. S. & Western	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Minn., St. Paul & Sault Ste. Marie	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Missouri Pacific	338	....	....	....	....	966,643	3,351	4.48	16.32	....	....	....	77.91	....	....	4.78	5.53	0.32	1.07	6.31	1.36	19.37	4.12	1.41	1.39
Mobile & Ohio	107	74	72,736	104,948	48,708	226,392	3,059	....	....	....	....	....	56.64	....	....	1 23	4.06	0.21	0.78	5.73	0.99	13.00	....	....	1.43
N. O. and Northeastern	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	..
N. Y., Lake Erie & Western	634	414	479,699	780,783	247,947	1,508,429	3,619	5.40	24.40	90.90	133.20	81.95	102.00	16.80	5.50	3.96	7.44	0.39	2.69	7.42	1.14	23.04	....	....	1.37
N. Y., Pennsylvania & Ohio	254	173	197,665	354,934	126,541	679,140	3,926	6.30	19.10	65.50	132.30	89.40	95.73	10.40	6.90	2.68	5.78	0.31	2.10	6.88	0.98	18.73	....	....	1.12
Norfolk & Western, Gen. East. Div.†	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
General Western Division†	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Ohio and Mississippi	105	....	142,467	137,804	82,452	362,723	3,454	....	....	....	....	....	71.25	....	....	2.41	2.87	0.24	1.17	5.46	1.47	13.56	....	....	0.79
Old Colony	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Philadelphia & Reading	....	....	464,738	299,655	902,042	1,666,485	....	....	....	....	....	....	75.41	....	....	5.30	5.04	0.37	.	5.82	0.42	16.95	....	....	....
Southern Pacific, Pacific System	741	694	637,442	867,314	262,738	1,767,494	2,547	5.88	14.86	....	....	....	68.87	....	....	3.50	17.21	0.23	2.30	7.35	1.07	31.66	....	....	5.01
Union Pacific	993	..	525,152	1,186,012	322,637	2,033,801	3,351	6.62	17.84	....	....	....	99.17	....	....	5.45	9.29	0.39	0.82	7.97	1.10	25.02	3.62	1.69	1.86
Wabash	425	355	472,161	609,034	216,760	1,297,955	3,660	5.29	17.30	68.42	103.35	51.11	74.29	12.91	5.97	3.40	4.66	0.31	....	6.11	0.87	15.35	2.47	1.04	1.16
Wisconsin Central	150	119	127,696	210,252	58,178	396,126	3,328	....	....	....	....	....	78.33	....	....	2.32	9.34	0.20	....	6.48	....	18.29	....	....	2.36

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars. Empty cars which are reckoned as one loaded car are not given upon all of the official reports, from which the above table is compiled. The Union and the Southern Pacific rate two empties as one loaded; the Kansas City, St. Joseph & Council Bluffs and Hannibal & St. Joseph Railroads rate three empties as two loaded; and the Missouri Pacific and the Wabash Railroads rate five empties as three loaded, so the average may be taken as practically two empties to one loaded.

* Switching engines allowed 6 miles per hour; wood, construction and gravel trains, 10 miles per hour.

† Wages of engineers and firemen not included in cost.

tion which will help to make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we all intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in November, has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS IN NOVEMBER.

York Station, Miss., November 1.—A passenger train on the East Tennessee, Virginia & Georgia Railroad was wrecked here while running at a high rate of speed this morning. A mule on the track was struck by the engine, which was turned over with the baggage car. Fireman Jim Avery was killed.

Brooklyn, N. Y., November 1.—A rear-end collision occurred on the Fifth Avenue Line of the Brooklyn Elevated Railroad this morning, in which the engine of the second train was somewhat damaged. It was sent back to the shops running wild, and owing to a sudden change in the signals at Myrtle and Hudson avenues, the engine was thrown from the track and turned over between the two tracks. The engineer, McKenna, in attempting to close his throttle, was severely scalded, and his right arm was badly torn in an effort to reverse the engine at the time. Fireman Walter Culley had his right leg and hip severely bruised.

Batavia, N. Y., November 1.—A collision occurred here this morning between an east-bound freight and local switch engine. Engineer Frank Walbridge of the switching engine was badly hurt.

Silver Creek, N. Y., November 2.—A passenger train on the New York, Chicago & St Louis Road ran into a rear-end second section of a freight train at this point to-night. The engineer and fireman jumped after the engine had been reversed. The engineer broke the bones in his wrist and was hurt about the chest. The fireman was bruised about the head and shoulders. The rear flagman had not gone back far enough to stop the train.

Keokuk, Ia., November 2.—A south-bound passenger engine on the St. Louis, Kansas & Northwestern Railroad was wrecked at Weaver, Ia., to-night. The engine was ditched and Engineer Trap killed.

St. Louis, Mo., November 2.—The boiler of a freight engine on the Iron Mountain Railroad exploded to-night, killing the fireman, George Schader. The engineer was instantly killed, and Ed. Koopke, the fireman, was thrown out into the muddy waters of the Mississippi, where his body was not recovered.

Philadelphia, Pa., November 3.—A car drifting down a grade on the Pennsylvania Railroad near Fifty-second Street to-day jumped the track and crashed into the engine of a west-bound market train. The engineer, James Hamlin, was found dead with two pieces of wood from the splintered car forced through his body. Reagan, the fireman, jumped, broke his ankle, and received other injuries to his legs.

Montpelier, Vt., November 3.—A passenger train on the Narrow Gauge Line branch of the Vermont Central ran into an open switch at Willard's Mill near Thompson to-day. The engine was thrown down a bank and Engineer Baldwin was seriously injured about the head. The fireman was slightly injured.

Goshen, N. Y., November 4.—A lurch of an engine hauling an express on the New York, Lake Erie & Western Railroad as it left the Bergen Tunnel to-day threw the engineer, Robert H. Compton, out of the cab. He received very painful injuries, but no bones were broken.

Batavia, N. Y., November 4.—A head-end collision occurred between a west-bound express and an east-bound freight on the Lehigh Valley Railroad near Morganville this morning. Two firemen and one engineer are reported as having been killed.

Cairo, Ill., November 5.—A fast Chicago & New Orleans express on the Illinois Central Railroad was wrecked by a misplaced switch near Allen this morning. Fireman Hammond was killed. It is supposed that the switch had been turned by would-be train robbers.

Reno, Nev., November 5.—A head end collision occurred on the Western Division of the Central Pacific Railroad between two freight trains this morning. Charles Givens, a fireman, was killed. Charles Bird, an engineer, had his left leg broken at the ankle. Thomas Moorhead, his fireman, was hurt about the head. The two trains came together in a cut at a sharp curve while going at a full speed.

Meadville, Pa., November 5.—A collision occurred between two switch engines on the New York, Pennsylvania & Ohio Railroad at this point to-day. Engineer Brown was severely cut about the head.

Lancaster, Pa., November 6.—Taylor Welsh, an engineer on the Pennsylvania Railroad, was hurt while attempting to disconnect the air-hose between two cars. As the coupling stuck, an iron bar was used to force them apart. One of the sections of the hose flew down, striking the engineer in the face, cutting him badly about the mouth.

East Des Moines, Ia., November 7.—A freight train on the Chicago & Great Western Railroad was derailed 8 miles south of Des Moines by running into a horse to-day. William Ferrell, the engineer, was badly injured.

Moberly, Mo., November 7.—A fast train on the Wabash Road ran into an open switch in the yards here this morning. The engine turned over on its left side, catching the fireman, William Malone, beneath it. He was fatally scalded, and died soon after. Frank Robertson, the engineer, was badly but not fatally hurt.

Lawrenceburg, Ky., November 8.—A freight train on the Louisville Southern Railroad ran into a rock car in a cut at this point to-day. The fireman was seriously injured.

Concord, N. H., November 9.—Daniel Coughlin, a fireman on the Concord, Montreal Railroad, while attempting to pass between two cars of a moving freight train, was thrown upon the rails, run over, and killed.

Toledo, O., November 9.—A south-bound passenger train ran into a north-bound freight train on the Hocking Valley Railroad just north of Rising Sun this evening. The collision was due to the disobedience of orders on the part of the engineer of the freight. Engineer L. H. Jones and Engineer James E. Kirlen were killed, also Fireman Jones of the passenger train.

Fort Wayne, Ind., November 10.—A west-bound limited express of the Pennsylvania Railroad ran into an open switch in the yards at this point this morning. The engine plowed through a box car on the side track, severely injuring Engineer David Raidy and Fireman Robert Griffen.

Lebanon, Ky., November 10.—A passenger train was derailed at Altamaton, on the Knoxville Division of the Louisville & Nashville Road, this morning. The engineer and fireman were badly bruised.

Newark, N. J., November 11.—Engineer Tunis and Fireman O'Brien, of the Rockaway Valley Railroad, were severely injured by the derailing of their locomotive about 2 miles from Morristown to-day. The fireman was injured by jumping, and the engineer by being struck by one end of a broken connecting-rod.

Windsor, Vt., November 11.—Joseph Pecoy, Jr., a fireman on the Boston & Maine Railroad, slipped and fell while stepping from the tender of his engine. He broke one of his arms above the elbow.

Lancaster, Pa., November 12.—A freight train of the Pennsylvania Railroad stopped with the caboose on the bridge over the turnpike to-night. Engineer Simon Brown, not knowing the caboose was on the bridge, stepped from it, and fell to the ground, 35 ft. below. He was seriously injured.

Greensburg, Pa., November 13.—Zachariah Gordon, a fireman on a freight engine, while stepping off his engine to-day had the small bones of his left leg broken in two places. The large tendon was also torn from the bone.

Philadelphia, Pa., November 12.—A rear-end collision occurred on the Iron Bridge, by which the Bound Brook Line crosses the Philadelphia & Reading Railroad, to-day. The engineer and fireman were slightly injured.

Newark, N. J., November 18.—Two freight trains collided at the Broad Street coal dumps at this point to-night. Engineer David Green was pinned down upon the right side of his cab and killed by escaping steam. His fireman, Charles Barkalow, was thrown over the boiler out of the cab, and escaped with only a few bruises.

Tipton, Mo., November 21.—A fast mail train on the Missouri Pacific collided with a switch engine at this city this evening. Fireman Frank Thompson, of the switching engine, and Fireman Harry Wheat, of the mail train, were considerably injured—Thompson probably fatally. William Clark, engineer, was also hurt in the back.

Norristown, Pa., November 21.—John H. Frohn, a fireman on the Philadelphia & Reading Railroad, was fatally injured by being run over by a train to-day.

Spokane, Wash., November 22.—An east-bound passenger train on the Great Northern Road was wrecked near Bonner's Ferry to-day. The engineer and fireman received serious cuts and bruises.

Omaha, Neb., November 22.—A fast freight train ran into an open switch just outside of the yards at Brand Island, on the Burlington route, to-night. The engine was entirely demolished. The engineer and fireman jumped while the train

was moving at a high rate of speed, and both received injuries from which they may die.

Perth Amboy, N. J., November 23.—Engineer David Orenford, of the Lehigh Valley Railroad, was stoned by a number of men while leaving Phillipsburg to-day. He was slightly injured.

Watertown, N. Y., November 23.—An engine standing in the yards of the Rome, Watertown & Ogdensburg Railroad started out to-night with no one in the cab. It ran into another engine, jarring open the throttle, which also started, and they both collided head-on with a passenger train from Cape Vincent. The engineer and fireman of the train jumped, and were only slightly injured.

Birmingham, Ala., November 24.—A disastrous wreck occurred near Carbon Hill, on the Kansas City, Memphis & Burlington Railroad, to-day. An east-bound freight from Memphis ran into a drove of cows. The engine and all of the freight cars left the track. Fireman Nutwilder was caught between the engine and tender and scalded to death. Engineer H. Barnard was also caught in the wreck and badly scalded.

Wilkesbarre, Pa., November 24.—N. T. Travis, an old non-union engineer, on the Lehigh Valley Railroad, was assaulted while on his way home to-night in a lonely part of the road. He was struck on the arm by a large stone, which disabled him for some time.

Olean, N. Y., November 24.—A collision occurred between a push engine and a work train on the Western New York & Pennsylvania Railroad, near Keating Summit, to day. Theodore Crane, fireman, was killed.

Geneva, N. Y., November 24.—A boiler on a Lehigh Valley Railroad engine exploded at North Hector to-night. The fireman was killed outright and the engineer fatally injured.

Richmond, Ind., November 25.—Curtis W. Boggs, fireman on the Pan Handle Line, fell from a water tank west of this city this morning and was seriously injured.

Perth Amboy, N. J., November 26.—A collision occurred between a Pennsylvania freight and a Lehigh Valley coal train in this city this morning. The engineer, Mallory, of the Lehigh Valley train, was killed. The engineer of the Pennsylvania engine and the two firemen escaped with slight injuries.

Batavia, N. Y., November 27.—A crown sheet on a Lehigh Valley engine was burned out and came down near this point to-night. The fireman was scalded from head to feet by escaping steam, but his injuries are probably not fatal.

New Orleans, La., November 27.—A tie placed across the track of a Mississippi Valley Railroad, 2 miles below Lutcher, caused the wreck of a gravel train to-day. Fireman Joseph Fogarty was killed, and Engineer Matthew Casey fatally injured.

Duluth, Wis., November 27.—Engineer William Ross was injured by the explosion of a boiler of a freight train near Arthur, on the Duluth and Iron Range Road, to-day. His lower limbs were paralyzed, and it is feared that his spine is injured. The cause of the explosion was an overheated crown-sheet.

Leavenworth, Kan., November 28.—A train on the Kansas Central Road ran into a small herd of stock west of here to-night. Engineer William Paterson received contusions of the knee, thigh, and ankle. Fireman Joseph Wertz had his ankle sprained.

Owego, N. Y., November 28.—An engine was derailed near the depot on the Lehigh Valley Railroad to-day, and was run into by a freight train. The engineer and fireman of the freight jumped and received some severe cuts and bruises.

St. Joseph, Mo., November 28.—A train on the Hannibal & St. Joseph Railroad ran into a train on the Kansas City, St. Joseph & Council Bluffs Railroad at their crossing in South St. Joseph yards to-night. Engineer Kimball, of the Hannibal, St. Joseph & Council Bluffs train, was thrown against his boiler and painfully hurt.

Erie, Pa., November 28.—A collision occurred between a freight train and a fast live-stock train near here, on the Lake Shore & Michigan Southern Railway, to-night. The freight was crossing over the east-bound track from a siding. Engineer Joel Gaines and Fireman W. Kirk were buried beneath their engine and killed. Engineer John Sohlinger and Fireman William Melpan had not time to jump, and the former was internally injured, while Melpan had both arms broken and was also internally injured.

London, Ont., November 28.—Thomas Brock, a fireman on the Canada Southern, fell from his train and was instantly killed.

Niagara Falls, N. Y., November 29.—Michael Haley, fireman on the New York, Lake Erie & Western Railroad, was thrown from his engine while rounding a curve to-night and quite seriously injured.

East Akron, O., November 29.—A rod on an engine hauling a passenger train broke at this place this morning. Escaping steam and flying particles severely injured the fireman.

Elmira, N. Y., November 30.—A flue on a Lehigh Valley freight engine collapsed at Van Etten this morning. Charles Swartout, the engineer, who was acting as pilot, was fatally scalded.

Our report for November, it will be seen, includes 50 accidents, in which 12 engineers and 16 firemen were killed, and 28 engineers and 22 firemen were injured. The causes of the accidents may be classified as follows:

Attacked by strikers	2
Boiler explosions	5
Broken side-rod	1
Collisions	18
Derailments	8
Falling from engine	7
Misplaced switch	5
Obstruction placed on track	1
Run over	2
Struck cattle	4
Uncoupling hose	1
Unknown	1
Total	50

PHINEAS DAVIS' STEAMBOAT.

In the last number of The American Engineer we gave an account of the life of Phineas Davis, and of his building the first locomotive, *The York*, for the Baltimore & Ohio Railroad. Since then we have received from Mr. John C. Jordan, who prepared the account from which our former article was chiefly made up, an interesting sketch of the first steamboat used on the Susquehanna River, and which was built by Davis & Gardner, the firm of which Mr. Davis was a partner. Mr. Jordan has been very assiduous in collecting all the available information about this boat, and from his account, published in the York, Pa., *Gazette* of December 6, 1893, we have made up the following account:

The first public mention of the steamboat, *Codorus*, was in the York *Gazette* of November 8, 1825, which says:

"The steamboat constructing of sheet iron at this place will be ready to launch this week. She will be taken off the stocks the end of this or the beginning of next week, and launched into the river Susquehanna at Mr. Keesy's, opposite Marietta. The following is a description of the boat taken by a gentleman of Philadelphia.

"The boat has 60 ft. keel, 9 ft. beam, and is 3 ft. high. It is composed entirely of sheet iron, riveted with iron rivets, and the ribs, which are 1 ft. apart, are strips of sheet iron, which by their peculiar form are supposed to possess thrice the strength of the same weight of iron in the square platform. The whole weight of iron in the boat when she shall be finished will be 1,400 lbs. That of the woodwork, deck, cabin, etc., will be 2,600 lbs., being together 2 tons. The steam-engine, the boiler included, will weigh 2 tons, making the whole weight of the boat and engine but 4 tons. She will draw, when launched, but 5 in., and every additional ton which may be put on board of her will sink her 1 in. in the water.

"The engine is upon the high-pressure principle, calculated to bear 600 lbs. to the inch, and the engine will be worked with not more than 100 lbs. to the inch. It will have an 8 H.P., and the boiler is formed so that the anthracite coal will be exclusively used to produce steam. The ingenuity with which the boiler is constructed and its entire competency for burning the Susquehanna coal are entitled to particular notice, and the inventors, if they succeed in this experiment, will be entitled to the thanks of every Pennsylvanian.

"The boiler is so constructed, as that every part of the receptacle for the fire is surrounded by the water intended to be converted into steam; and thus the iron is preserved from injury by the excessive heat produced by the combustions of the coal. Its form is cylindrical, its length about 6 ft., and it will be placed upright in the boat, occupying with the whole engine not more than 10 ft. × 6 ft.

"The engine is nearly completed, Messrs. Webb, Davis & Gardner being its constructors. The boat, which is the work of Mr. Elgar, is in great forwardness. The whole cost of the boat and engine will be $3,000."

[The Mr. Elgar referred to was probably John Elgar, who afterward was connected with the Baltimore & Ohio Railroad and resided in Baltimore. The writer of this note was well acquainted with him about the year 1855. He was a man of great ingenuity and a good practical mechanic.]

On November 15, 1825, the boat was finished, and was the occasion of not a little enthusiasm on the part of the citizens of York. The *Gazette* of this date says:

"The steamboat, which was built at this place, was drawn through our streets yesterday morning, on her way to the Susquehanna. She is placed on eight wheels, and such was the interest felt on the occasion, that notwithstanding being in weight more than 6,000 lbs., the weather rainy and disagreeable, the citizens attached a long rope to her, and about 60 or 70 taking hold, drew her from the west side of the bridge to the upper end of Main Street, amid the shouts and huzzas of a multitude.

"She has been named after the beautiful stream on whose banks she was brought into existence—*Codorus*—a name, that should her destiny be prosperous, that will not in future be pronounced without associating the most pleasing recollections in the minds of the citizens of this place."

On November 22 she was launched in the Susquehanna, when she was tried, and it was said:

"It is ascertained that by giving her only half the steam power, the boat is propelled against the current and a strong wind about 5 miles an hour. In the draft of water the calculation of the builders were correct, with 40 persons on board her draft is not more than 8 in."

The local papers of the period give accounts of the boat ascending the river the following spring to Harrisburg, and as far as Wilkesbarre and Bloomsburg. The Wilkesbarre *Democrat* of April 14, 1826, says of it:

"This experiment entitles Mr. Elgar to much credit and esteem, and we heartily wish him a pleasant journey to the head-waters of the Susquehanna—the place, we believe, of destination."

The York *Gazette* of July 25, 1826, indulges in rather gloomy reflections about it, and intimates that the anticipations of the promoters of this enterprise were not only unrealized, but so disappointed were the stockholding investors that it became a question among them to what use the steamboat could possibly be put in order to bring them any revenues at all.

To show that dissatisfied stockholders existed then as now is shown by the fact that Mr. Jordan reports that on April 5, 1827, two years after her first launching, one of the stockholders writes to the *Gazette* as follows:

"Between $2,000 and $3,000 have been expended upon the construction of this boat, and from the use, or rather no use being made of it, after it was built, the question may rationally be asked for what purpose has this large sum been expended, or what was the object of building the boat? Was the money levied merely to show that steamboats could be built at this place? If this was the sole object the whistle has been well paid. But I am in hopes some better use might be made of it, than suffering it to be dismantled, and becoming a prey to the corrosions of time. Suppose some of the stockholders were to employ some of the arkmen to tow it down to the tide, where perhaps it might be applied to some useful purpose. It is better to wear than rust out, half a loaf is better than no bread. Something could perhaps be obtained for it to be used as craft in the bay. At all events, a trial to do something ought to be made, and who knows what luck the stockholders might have."

What ultimately became of the *Codorus* the author of this interesting account has been unable to learn.

NOTES AND NEWS.

Contract for Gunboats.—The contract for the construction of two new gunboats, for which the Newport News Ship & Dry Dock Company, of Newport News, Va., was the lowest bidders, has been awarded to them. The price for each vessel is $280,000. The contract for the third boat has not yet been awarded.

Trial of the Cruiser "Olympia."—At the trial of the cruiser *Olympia*, on the contractor's trial trip, she made a record faster than that made by the *New York*, which was 21 knots, having run 21¼ knots. The maximum speed with the maximum power was 21.26 knots; the average for 68 hours, with heavy sea and strong winds, slightly under 21 knots.

Preservation of Wire Rope.—An expert gives the following recipe for preserving wire ropes that are to be carried under water or under the earth's surface. It consists of a mixture of 35 parts of slacked lime, and from 50 to 60 parts of tar is found, thus far to be a very satisfactory method as compared with other processes which have been resorted to. The compound is boiled and applied hot. For dry-laying cables a thick mixture of graphite boiled in tallow and one of crude linseed-oil and vegetable tar have both proved a success.

Disappearing Gun Carriage Trial.—A test of the Buffington-Crozier disappearing gun carriage was held at Sandy Hook on the afternoon of December 14. The test was for rapid firing, and 10 projectiles were fired from an 8-in. gun with full charges of 125 lbs. of powder each. All shots were fired out to sea, and the 10 rounds were fired in 12 minutes and 8 seconds. The carriage worked perfectly, and has proven itself to be a success. In our next issue we will have an illustration descriptive of the carriage.

Sea Coast Defenses.—At the end of the current calendar year the War Department will be in possession of nine 12-in. guns, twenty 10-in. guns, and thirty-four 8-in. guns ready to be mounted on carriages. Also seventy-five 12-in. mortars. In addition to the product of the Army gun factory, which is now in operation at Watervliet, the Government has contracted with private parties for 100 guns of these calibers, the first of which should be delivered to the Department for test before June 1, 1894. The manufacture of heavy ordnance is thus keeping pace with current needs, but in order to render these guns available fortifications must be prepared, and for this purpose appropriations from Congress are required.

Novel Ticket on the Belgian State Railways.—An innovation in passenger rates has been introduced on the Belgian State railroads, in the sale, at a low rate, of subscription tickets, good for various periods, which entitle the holder to travel as often and as far as he may like in any part of the country during the stated period, on any of the lines belonging to the system.. The prices of these tickets for 15 days are 50 francs for first class, 38 francs for second class, and 25 francs for third-class passengers. This is about like paying $10 for a first-class ticket good on all the lines of the New York Central for as many journeys as one chooses to take, for 15 days. Only no single journey nearly as long as from New York to Buffalo is possible in Belgium.

Railway in the Holy Land.—There is now a great railway system in the course of construction which will girdle the Holy Land from one end to the other. A French company has secured a concession for a line from Beirut to Damascus, and has already commenced work on a narrow-gauge road. An English syndicate is now building a railway from Halfa to Damascus, which will be about 140 miles long, starting from Halfa, finding its way along the northern base of the range of Carmel to the plain of Esharon, through the valley east of Nazareth. Leaving Mount Tabor it will cross the river Jordan on a trestle, and then to the point known as Majemeh, where the Little Jordan joins the greater rivers At this point the road will border on the southern shore of Galilee, and almost without a curve along the famous wheat region, biblically known as the plains of Bashan, thence to the southern gate of Damascus.

Standard Time in Italy.—On November 1 "standard time" was introduced on the Italian railroads, being that of the fifteenth degree east of Greenwich, the same as in Germany and Austria, called in Europe "Central European Time." This meridian passes some 50 miles east of Naples. having but a small fraction of the kingdom east of it, and comparatively thinly peopled. Heretofore all Italian railroads, except those in Cicily, have used the time of Rome, which is quite central. At the same time the hours of the day will be numbered from 1 to 24, beginning with midnight. Twenty-four o'clock will seem quite natural to the Italians, as until recently the hours were so counted universally, beginning, however, with sunset instead of midnight. In the greatest of Italian novels, an old priest, lamenting that better times have come too late for him to enjoy them long, says that it is truly a great thing for the young, but it is "half-past twenty-three o'clock" with him.

Measuring High Temperatures.—Professor Roberts-Austen, in England, has recently devoted much attention to the measurement of very high temperatures, and has obtained results of great interest in connection with the molecular structure of alloys. He has now turned his attention to providing a recording pyrometer for use in works, and this new instrument he exhibited together with some remarkable photographic curves obtained by its aid. The pyrometer itself is a thermo-junction of platinum and platinum alloyed with rhodium; this is attached to a galvanometer and the spot of light from its mirror is received on a revolving drum covered with sensitized paper. The curves exhibited give a 24 hours' record of the variations in the temperature of the blast supplied to furnaces smelting iron. It is thus possible to account for variations in the working of these large structures, and by insuring regularity of work to avoid the occurrence of these variations, also to effect economies of fuel, which, it is antici-

pated, will attain very large proportions and will prove to be of great industrial importance in conducting this important branch of metallurgy.

Summary of Railway Wrecks.—The *Wall Street News* makes the following summary of the more serious railroad accidents and their causes since the beginning of the year:

Date.	Place of Accident.	Killed.	Injured.
Jan. 21	"Big Four;" open switch, Alton, Ill...	32	36
Jan. 28	Chicago Great Western; derailment, Kent, Ill.......	3	10
Feb. 21	West Shore; derailment, Palmyra, N. Y	3	16
Feb. 22	Pennsylvania; collision, West Philadelphia, Pa...	4	20
Feb. 22	Schuylkill Valley; collision, near Phœnixville, Pa...	4	2
April 3	Jacksonville; collision..........	4	7
April 25	Bare Rock; collision, Somerset, Pa..........	11	2
May 6	"Big Four;" derailment, Lafayette, Ind.........	10	14
May 6	Dayton and Michigan; collision..........	5	0
May 30	Tyrone and Clearfield; collision, Tyrone, Pa.........	5	11
June 20	Long Island Railroad; derailment, Parkville, L. I...	10	26
July 13	West Shore; derailment, Newburg, N. Y..........	5	21
July 17	Grade crossing accident, Chicago..........	5	12
July 25	Baltimore and Ohio; derailment, Akron, O..........	3	25
Aug. 4	Lake Shore; derailment, Lindsay, O..........	3	25
Aug. 16	Boston and Albany; broken bridge	17	28
Sept. 7	Fort Wayne; collision, Colehour, Ill..............	13	17
Sept. 18	"Big Four;" collision, Manteno, Ill..........	8	18
Sept. 22	Wabash; collision. Kingsbury, Ind..........	14	45
Sept. 27	Grand Trunk; Bellevue, Mich	8	5
Oct. 13	Michigan Central; collision, Jackson, Mich	12	40
Oct. 16	Wabash; collision, East St Louis..........	0	73
Oct. 19	Illinois Central; collision, Otto, Ill..........	0	10
Oct. 20	Grand Trunk; collision, Battle Creek, Mich..........	27	36
	Totals...	201	548

DETENTIONS ON RAILROADS FROM DEFECTS IN LOCOMOTIVES.

In response to a letter of inquiry with reference to this subject, which appeared in The American Engineer of last month, we are able to give the following statement of total engine mileage made on each division of the road, covered by the tabular report published on p. 548 of our November number. The following figures give besides the mileage the number of detentions for the same and the number of miles run to one detention. This, of course, varies somewhat on some divisions where there are only a few old engines, as on the B Division, where the miles run to one detention is much lower than on others. The same may be said of Divisions A and F where some of the power is old. The average, however, is one detention to 24,618 miles.

The table published in November covered only machinery failures and not boiler failures. We hope to give some reports of these in the future.

Summary of Reports of Detentions to Trains from Defective Machinery, Year ended June 30, 1893, on Mileage Basis.

Division.	Total Mileage.	Total No. of Detentions.	Miles Run to One Detention.
Division A..........	2,955,858	91	32,482
Division B	5,934,874	152	39,042
Division C..........	3,853,707	137	28,129
Division D	337,733	42	8,041
Division E..........	2,273,977	81	28,074
Divisions F and G	3,289,431	234	14,057
Division H..........	4,444,649	215	20,673
Division I..........	3,986,263	122	32,674
Division J	3,569,884	138	25,869
Division K..........	446,910	51	8,763
Grand Total	31,092,786	1,263	24,618

The article which was published on pp. 505–507 of our November number, and the table on p. 548 relating to this subject, and also the blanks used for reporting detentions on the New York Central Railroad, which were given on p. 595 of our December issue, have attracted the attention of a number of railroad managers, and our readers will, we think, be interested in the following comments made thereon by several of them. Mr. P. Leeds, Superintendent of Machinery of the Louisville & Nashville Railroad, says:

To the Editor of the American Engineer and Railroad Journal:

Your circular letter to our General Manager has been referred to me. We have never made a summary of detentions and other causes outlined in that report, but every day I get a report of every detention on the road, from any cause whatever, and the number of minutes' delay on account of it. This report I criticise carefully, and take up every case individually at once, at the same time making memorandum of all breakages that would indicate weakness of construction, separate and distinct from those that are from causes of any neglect of inspection in the case of the engines. This I call my laboratory report, as, no matter what the figures may show, any failure of any one part is looked upon by me as *prima facie* evidence that there is a weakness in that point, and attention is given at once to strengthening it in our old engines by additional bracing, and in our new ones by change in design to meet the defect.

As these reports give every minute delayed, they are of a great deal of value in saving discussion and argument with parties who insist that they can make great improvements in our lubrication, etc.

For instance, where any one comes in and claims they can reduce our delays on account of hot boxes, I hand them a few weeks of these reports, and ask them to carefully go over them and note all delays on account of hot boxes, assuring them that they will find absolutely correct data in such records. This not only gives me the time that they spend in investigating such reports to attend to other business, but to a great extent reduces the number of incredulous smiles that meet a man when he makes an offhand assertion that on such a system as this the delays on account of such trouble do not exceed so many minutes per month.

The worst feature in a system in regard to anything of this kind is that, with the exception of the equipment that belongs to a certain division, every one tries to shift the responsibility on some one else on some other division. In other words, all the detention is not attributable to neglect on the division on which they occur, and it keeps any one hustling to trace down where the responsibility rests. At the same time, I believe I shall have a form of this kind made up on each division and reported, as it will surely place before each Master Mechanic the detentions on account of equipment that is directly under his charge, and by making a general report similar to the one you have, and sending to each Master Mechanic monthly, it will give a comparative idea of the result of his own practice against that of others.
P. Leeds.

Mr. W. H. Baldwin, Jr., General Manager of the Flint & Père Marquette Road, says:

This table is very interesting, and I shall at once take steps to keep a record of all detentions on account of defective machinery under the headings as prescribed in this report. I think it would be very profitable information if all roads would keep this data under the same headings, as we may thereby learn the weakest parts from the experience of all. I thank you very much for bringing this matter to my attention, and remain,
W. H. Baldwin, Jr., General Manager.

Mr. G. Clinton Gardner, General Manager of the Ohio River Railroad, writes:

In connection with the subject of causes of detentions, permit me to suggest that you associate with it statistics of broken rails, as the most prolific cause of detention is due to failure of springs and their attachments. It may be found to be caused by bad track and road bed, resulting in broken rails, and as the winter approaches you perhaps will find the failure of springs to increase.

It is evident that in most cases Maintenance of Way does not receive as much attention as it should, and is always the first department to be attacked in a reduction of expenses.
G. Clinton Gardner.

An officer of the Pennsylvania lines west of Pittsburgh says:

I think the report is a very useful one, and on the lines west of Pittsburgh it has been in use for 10 or 12 years, and is of course being continued.

Another prominent railroad officer writes:

I am glad to see that you are working up an interest in this matter; nothing pays a railroad company more than this does.

In the last issue of your paper you published a form for reporting defects of equipment in use on the New York Central. I have several criticisms to make on this form:

1. If every part of a locomotive and tender was put on the form, and the same system was followed out, it would be of a most voluminous description.

2. That it would induce enginemen to report work on account of its convenience, that they would not do otherwise.

3. And the one I consider the most serious objection is the fact that the Superintendent of Machinery has no check on the form; in other words, if a master mechanic or general foreman should fail to send this report in, or to suppress it, the Superintendent of Machinery would probably be none the wiser, and hence the probability is that a great many of them are not sent to him which should be. He may have a check on it, but it is not shown in your article.

I think my method of procedure is better than this, and I enclose our Form 1,004 (see copy below), which is known as the Engineman's Form, and on which, as soon as he comes in, and there has been any detention at all to his train either of cars or engines, he makes a report of it, stating what caused it as near as he can judge. This goes to the round-house foreman or to the general foreman of the station, who verifies his statement and tries to locate the trouble; it is then sent to the Master Mechanic, who confirms the report or takes any action necessary. Many times a man has to go before a Board of Inquiry and be tried; it then goes to the Superintendent of Motive Power, who often returns it for further investigation, and finally it comes to me, and sometimes even I take up the question and go into it; but whatever is done is shown on the form in full, and the reason for doing it. In addition we have hundreds of small blue prints of each part of the machinery, with which each station is supplied, and they pin one of these small blue prints to the form, and mark in red ink on it the defect or breakage. I found when I first took hold of the road that these reports did not come to me with regularity, were often suppressed if it proved convenient to do so, and, in fact, it was utterly worthless without some check, and this I devised, as follows:

The conductors have to report any detentions to their trains to the Train Masters, and a record of these is kept, with the cause, and each Division Superintendent reports to me on a second form, No. 2,456 (see copy below), the detentions to all trains on his division each month. This gives me a check against the division master mechanic, and the division master mechanic gives me a check against the superintendent, the information coming through two different sources. In this way we get everything, and the report becomes valuable.

Our men are now thoroughly broken into it and there is no objection to its use, and we have a full record at all times of everything that takes place. Each month I compile a statement of divisions of detentions, etc., a sample copy of which I send you for the month of September. You will see it covers the four following reports:

Table 1. Reports of detentions to trains from defective machinery.

Table 2. Reports of detentions to trains from steam failures.

Table 3. Reports of detentions to trains from carelessness.

Table 4. Report showing the miles run to one detention. I do not think anything more simple or complete can be devised than this form, and it has given us the most excellent results. We are eliminating the weak points wherever it is practicable to do so, and we find now that our detentions to trains from defective machinery, with everything reported, are far less than they were in 1889, when we were getting only about half the reports, and in another two or three years I hope with proper system to reduce them 25 or 30 per cent. more.

Form 1,004.

.... RAILROAD COMPANY.

ENGINEMAN'S REPORT OF ACCIDENT,

MACHINERY OR STEAM FAILURE.

Date of Accident............	Engine Number...Train Number...
Time of Accident, Hour.....Min.....	Engineman...........................
On Time or Late....Hours....Min...	Fireman ....
Delayed by Accident.. " .... "	Conductor......... .. ..
Location..............................	

CAUSE OF ACCIDENT OR STEAM FAILURE.

....

....

CARS OFF TRACK AND DAMAGED.

Initials.	Class.	Number.	Damage.
....	....	....	....
....	....	....	....
....	....	....	....

DAMAGE TO ENGINE AND TENDER.

....

....

....

Respectfully Submitted,

....................................Station,

Date...............................189

....

Engineman.

Enginemen must fill this neatly and carefully, with full explanation of the cause of Accident or Failure of Machinery, and deliver as promptly as possible to the Division Master Mechanic or General Foreman.

Master Mechanics or General Foremen will either confirm Enginemen's Statements or make satisfactory explanation of same, with estimated amount of damage to Engine, Tender or Cars, and forward promptly to the Sup't of Motive Power, who will investigate further if necessary, and then send to Gen'l Sup't Motive Power for file in his office.

Form 2,456.

.............................RAILROAD COMPANY.

SUPERINTENDENT'S REPORT OF ACCIDENT

TO MACHINERY OR STEAM FAILURE ON LOCOMOTIVES.

For............................*Div.* *Month of*.....................189

Engine Number.	Train Number.	Date of Accident.	Time Delayed by Accident.	Cause of Detention.
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....

This Form to be made out at the end of each month in the Division Superintendent's Office and forwarded to the Superintendent of Motive Power.

....

Division Superintendent.

TABLE I.

REPORT OF DETENTIONS TO TRAINS FROM DEFECTIVE MACHINERY, SEPTEMBER, 1898.

DIVISION A, PASSENGER.

Air hose clamp breaking, 851	1	
Air pump valves breaking, 620, 856	2	
Cross-head gib breaking, 857	1	
Grate arrangement breaking, 853	1	
Spring rigging breaking, 854	1	
Valve stem packing—ball joints breaking	1	7

FREIGHT.

Throttle packing blowing out, 289	1	1

DIVISION B, PASSENGER.

Main rod strap breaking, 827	1	1

FREIGHT.

Eccentric breaking, 581	1	
Main pin breaking, 885	1	
Piston head nut breaking, 1,211	1	3

DIVISION C, PASSENGER.

Air pump failing, 890	1	
Eccentric bolt breaking, 707	1	
Furnnace door breaking, 812	1	
Spring hanger breaking, 814	1	
Tender truck truss rod breaking, 816	1	5

FREIGHT.

Crosshead gib bolts breaking, 437, 443, 508	3	
Frames breaking, 388, 408, 416, 449, 495, 495, 390	7	
Grate arrangement breaking, 498	1	
Muffled pop breaking, 582	1	
Safety balance stud breaking, 373	1	
Side rod bolt breaking, 594	1	
Throttle pipe lug breaking, 182	1	
Throttle rigging breaking, 378	1	
Valve stem breaking, 490	1	17

DIVISION D, PASSENGER.

Relief valve breaking, 745	1	1

FREIGHT.

Safety valve rod breaking, 7	1	1

DIVISION E, FREIGHT.

Driving axle breaking, 560	1	
Eccentric breaking, 554	1	
Guide breaking, 549	1	
Spring hanger breaking, 571	1	4

DIVISION F, FREIGHT.

Cylinder loose and working, 404	1	
Crosshead gib breaking, 855	1	
Eccentric rod breaking, 1,206	1	
Eccentric rod bolt breaking, 1,200	1	
Crank pin bolt breaking, 556	1	
Spring hanger breaking, 453	1	
Spring rigging breaking, 546, 1,202	2	8

DIVISION G, FREIGHT.

Crosshead gib breaking, 473	1	1

DIVISION H, PASSENGER.

Air pump piston rod nut thread stripped, 846	1	
Air pump packing nut thread stripped, 1,406	1	
Eccentric rod clevis bolt breaking, 702	1	
Grate arrangement breaking, 846	1	
Spring rigging breaking, 763	1	5

FREIGHT.

Crosshead gib breaking, 1,362	1	
Eccentric breaking, 535	1	
Frame breaking, 515	1	
Side rod strap breaking, 510	1	4

DIVISION I, PASSENGER.

Air hose bursting on engine, 719, 1,404	2	
Eccentric breaking, 660, 876	2	
Piston key breaking, 793	1	
Piston rod breaking, 719	1	
Safety valve lever stem breaking, 726	1	
Tender truck, gum seat in triple valve defective, 662	1	8

FREIGHT.

Driving spring breaking, 292	1	
Piston rod breaking, 999	1	
Safety valve lever fulcrum breaking, 987	1	
Steam chest breaking, 1,119	1	
Throttle packing blowing out, 958, 962	2	6

DIVISION J, PASSENGER.

Air pipe under tank breaking, 769	1	
Cylinder head breaking, 795, 877	2	
Engine truck springs breaking, 705	1	
Main rod breaking, 877	1	
Piston rod breaking, 779	1	
Spring hanger breaking, 768	1	
Spring rigging breaking, 705, 722	2	9

FREIGHT.

Air signal pipe breaking on engine, 790	1	
Crank pin nut thread stripped, 926	1	2

DIVISION K, PASSENGER.

Lifting shaft arm breaking, 1,385	1	1

FREIGHT.

Eccentric strap bolts breaking, 109	1	1

RECAPITULATION.

Division.	Passenger.	Freight.	Total.
Division A	7	1	8
Division B	1	3	4
Division C	5	17	22
Division D	1	1	2
Division E	0	4	4
Division F	0	8	8
Division G	0	1	1
Division H	5	4	9
Division I	8	6	14
Division J	9	2	11
Division K	1	1	2
Total	37	48	85
Last month	22	43	65
Same month last year	45	60	105

TABLE II.

REPORT OF DETENTIONS TO TRAINS FROM STEAM FAILURES, SEPTEMBER, 1893.

	5 Mins. & under.	Over 5 Mins.
DIVISION A, PASSENGER.		
Air pump exhaust coming loose, 852	1	
Bad coal, 875, 875		2
Injector intermediate check valve breaking, 852	1	—
	2	2
FREIGHT.		
Incompetent engineman, 1,359		1
Injector failing to work, 1,358		1
		2
DIVISION B, PASSENGER.		
Bad coal, 756, 1,411, 1,415, 1,416	1	3
Bad fire, 1,402		1
Flues stopping up, 885	1	
Rivet head blown off, 756		1
	2	5
FREIGHT.		
Injector check valve breaking, 365		1
Steam pipes leaking, 497		1
		2
DIVISION C, PASSENGER.		
Bad coal, 811, 811, 811, 816, 818, 821	2	4
Bad coal and no arch in engine, 811, 811, 812, 814		4
Bad coal and flues leaking, 814, 814		2
Bad coal and incompetent fireman, 816, 818, 819		3
Flues bursting, 713		1
Flues stopping up and no arch in engine, 814		1
	2	15
FREIGHT.		
Bad coal and flues leaking, 390, 432		2
Exhaust base liner breaking, 584		1
Exhaust pipe working loose, 584		1
Furnace leaking, 492		1
Flues bursting, 354		1
Flues leaking, 361, 390, 437, 474, 520		5
Injector check valve breaking, 511		1
Steam pipes leaking, 360, 594		2
		14
DIVISION D, PASSENGER.		
Bad coal, 742		1
Flues leaking, 746		1
		2
FREIGHT.		
Bad coal, 7, 7, 396		3
Bad coal and flues leaking, 408		1
Flues leaking, 429		1
Flues stopped up and steam pipes leaking, 410		1
		6
DIVISION E, PASSENGER.		
Bad coal, 1,306		1
Flues leaking, 1,306		1
		2
FREIGHT.		
Bad coal, 412, 412, 412, 559, 574		5
Blow in valves, 566		1
Flues leaking, 558		1
Flues stopped up, 541		1
Incompetent fireman, 566, 589, 589, 589, 589		5
		13
DIVISION F, FREIGHT.		
Engine foaming, 374, 448		2
Flues leaking, 572, 1206		2
Injector check valve breaking, 1,209		1
Steam pipes leaking, 1,201		1
		6
DIVISION G, FREIGHT.		
Flues bursting, 372		1
Furnace patch bolt blowing out, 521		1
		2
DIVISION H, PASSENGER.		
Bad coal, 845, 845		2
Engine foaming, 762		1
Flues leaking, 839, 846, 740		3
Steam pipes leaking, 842, 843		2
Injectors failing to work, account sawdust in tank, 846		1
..........., 844		1
		10
FREIGHT.		
Bad fire, 502		1
Engine foaming, 80		1
Flues leaking, 502, 1,360, 1.500		3
Injectors failing to work, 446		1
Pad bolt blowing out, 535		1
Steam pipes leaking, 490		1
..........., 519, 1,112		2
		10
DIVISION I, PASSENGER.		
Flues leaking, 608, 662		2
		2
FREIGHT.		
Diaphragm loose, 1,386		1
Flues bursting, 958		1
Flues leaking, 956		1
Flues and mud ring leaking, 339		1
Incompetent fireman, 1,377		1
		5
DIVISION J, PASSENGER.		
Exhaust nozzle too large, 882		1
Flues leaking, 741, 769, 769		3
Injectors failing to work, 796		1
Steam pipes leaking, 882		1
		6
FREIGHT.		
Boiler check stuck and injectors failing to work, 789		1
Flues bursting, 785, 786		2
Flues leaking, 923, 1,346, 1,361		3
Injector check valves breaking, 782, 787		2
Injector cone loose and filled with cinders, 929		1
		9
DIVISION K, PASSENGER.		
Bad coal, 267		1
Flues leaking, 771, 771, 771		3
		4

RECAPITULATION.

Division.	Passenger. 5 Mins. and under.	Passenger. Over 5 Mins.	Freight. 5 Mins. and under.	Freight. Over 5 Mins.	Total. 5 Mins. and under.	Total. Over 5 Mins.
Division A	2	2	0	2	2	4
Division B	2	5	0	2	2	7
Division C	2	15	0	14	2	29
Division D	0	2	0	6	0	8
Division E	0	2	0	13	0	15
Division F	0	0	0	6	0	6
Division G	0	0	0	2	0	2
Division H	0	10	0	10	0	20
Division I	0	2	0	5	0	7
Division J	0	6	0	9	0	15
Division K	0	4	0	0	0	4
Total	6	48	0	69	6	117
Last month	8	40	2	68	10	108
Same month last year	1	30	2	100	3	130

TABLE III.

CARELESSNESS.

REPORT OF DETENTIONS TO TRAINS FROM OTHER CAUSES THAN STEAM FAILURES AND DEFECTIVE MACHINERY, SEPTEMBER, 1893.

DIVISION A, PASSENGER.		
Hot crank pin, 875	1	
Hot driving box, 876	1	
Hot engine truck box, 854, 875, 875	3	5
FREIGHT.		
Headlight exploded, 1,398	1	1
DIVISION B, PASSENGER.		
Hot engine truck box, 633	1	
Wet sand in box, 1,409	1	2
FREIGHT.		
Staybolts pulled out account low water, 1,240	1	
Soft plugs melting out, 591	1	2
DIVISION C, PASSENGER.		
Hot engine truck boxes, 816, 821	2	
Hot main brass, 816	1	3
FREIGHT.		
Eccentric bolts coming loose, 583	1	
Hot main brass, 506	1	
Soft plug melting out, 584	1	
Waste and sparks in injector, 360	1	4
DIVISION D, PASSENGER.		
Hot engine truck box, 746	1	
Hot main brass, 745	1	
Wheel guard bolt working loose, 745	1	3
FREIGHT.		
Hot driving box, 428	1	
Hot main pin, 429	1	2
DIVISION E, PASSENGER.		
Hot engine truck box, 1,305	1	
Soft plug melting out, 707	1	2
FREIGHT.		
Hot driving box and crank pin, 560	1	
Hot main brass, 1,232	1	
Soft plug melting out, 552	1	3
DIVISION F, FREIGHT.		
Eccentric rod bolt nut working off, 1,201	1	
Eccentric set screws working loose, 1,206	1	2
DIVISION G, PASSENGER.		
Eccentric bolt nut working off, 801	1	1
FREIGHT.		
Eccentric bolt nuts working off, 448	1	1
DIVISION H, PASSENGER.		
Driving wheels off track, account too much end play, 846, 846, 846	3	
Eccentric rod clevis bolt nut lost, 841	1	
Hot engine truck boxes, 843, 846	2	
Hot main pin, 841	1	
Hot tender truck box, 843	1	
Wheels slipping, bending side rods and bursting main wheel, 1,407	1	9
FREIGHT.		
Crosshead gib breaking, account insufficient lubrication, 1,363	1	
Crosshead lined too tight in Connellsville shop, 1,362	1	
Hot main pin, 1,379	1	
Hot tender truck box, 1,378	1	
Rocker arm band coming off, 1,576	1	5
DIVISION I, PASSENGER.		
Air drum studs working loose, 1,351	1	
Eccentric set screws working loose, 1,388	1	
Hot engine truck boxes, 828, 1,388, 1,404	3	
Hot main brass, 608	1	6
FREIGHT.		
Hot main pins, 1,386, 1,386	2	
Soft plug leaking, 959	1	
Tire working loose, 999	1	4
DIVISION J, PASSENGER.		
Hot engine truck box, 705	1	
Hot main pin, 888	1	
Soft plug melting out, 741	1	3
FREIGHT.		
Engine slipping, 1,366	1	
Soft plug melting out, 787	1	2
DIVISION K, PASSENGER.		
Hot engine truck boxes, 1,384, 1,391	2	
Hot main pin, 1,384	1	3
FREIGHT.		
Eccentric loose, 1,553	1	1

RECAPITULATION.

Division.	Passenger.	Freight.	Total.
Division A	5	1	6
Division B	2	1	3
Division C	3	4	7
Division D	3	2	5
Division E	2	3	5
Division F	0	2	2
Division G	1	1	2
Division H	9	5	14
Division I	6	4	10
Division J	3	2	5
Division K	3	1	4
Total	37	26	63
Last month	33	23	56
Same month last year	26	36	62

TABLE IV.

STATEMENT OF DETENTIONS TO TRAINS, SEPTEMBER, 1893, COMPARED WITH SEPTEMBER, 1892, ON MILEAGE BASIS.

Division.		Mileage.	Number of Detentions. Defective Machinery.	Number of Detentions. Steam Failures.	Number of Detentions. Other Causes.	Defective Machinery. Miles Run to one Detention.	Steam Failures. Miles Run to one Detention.	Other Causes. Miles Run to one Detention.	All Causes. Miles Run to one Detention.
Div. A.	1893—Pass	109,286	7	4	5	15,612	27,322	21,857	6,830
	1892—Pass	122,944	5	3	7	24,589	40,981	17,563	8,196
	1893—Frt.	127,590	1	2	1	127,590	63,795	127,590	31,898
	1892—Frt.	133,348	3	0	0	44,449	.....	......	44,449
Div. B.	1893—Pass	189,068	1	7	2	189,068	27,009	94,532	18,906
	1892—Pass	212,939	10	4	2	21,294	53,235	106,469	13,309
	1893—Frt.	260,847	3	2	1	86,949	130,424	260,847	43,475
	1892—Frt.	318,173	2	1	4	159,087	318,173	79,543	45,453
Div. C.	1893—Pass	65.113	5	17	3	13,023	3,830	21,704	2,605
	1892—Pass	72,902	2	1	3	36,451	72,902	24,301	12,150
	1893—Frt.	232,570	17	14	4	13,681	16,612	58,143	6,645
	1892—Frt.	250,837	7	18	7	35,834	13,935	35,834	7,839
Div. D.	1893—Pass	12,105	1	2	3	12.105	6,053	4,035	2,018
	1892—Pass	11,475	2	1	0	5,738	11,475	......	3,825
	1893—Frt.	20,781	1	6	2	20,781	3,464	10,391	2,309
	1892—Frt.	20,591	4	11	4	5,148	1,872	5,148	1,084
Div. E.	1893—Pass	38,282	0	2	2	......	19,141	19.141	9,571
	1892—Pass	43,089	2	10	1	21,545	4,309	43,089	3,315
	1893—Frt.	153,732	4	13	3	38,433	11,826	51,244	7,687
	1892—Frt.	147,902	5	22	6	29,580	6,723	24,650	4,482
Divs. F. and G.	1893—Pass	69,841	0	0	1	......	......	69,841	69,841
	1892—Pass	82,570	4	2	2	20,643	41,285	41,[illegible]	10,321
	1893—Frt.	199,118	9	8	3	22,124	24,889	66,373	9,956
	1892—Frt.	199,970	17	16	1	11,763	12,498	199,970	5,881
Total, Main Stem Div.	1893—Pass	374,404	7	28	11	53,486	13,372	34,037	8,139
	1892—Pass	422,975	20	18	8	21,149	23,499	52,872	9,196
	1893—Frt.	867,048	34	43	13	25,501	20,164	66,696	9,634
	1892—Frt.	937,473	35	68	22	26,785	13,786	42,612	7,499
Div. H.	1893—Pass	117,697	5	10	9	23,539	11,770	13,077	4,904
	1892—Pass	120,135	2	4	6	60,068	30,034	20,023	10,011
	1893—Frt.	193,929	4	10	5	48,482	19,393	38,786	10,207
	1892—Frt.	251,963	11	26	5	22,906	9,691	50,393	5,999
Div. I.	1893—Pass	112,600	8	2	6	14,075	56,300	18,767	7,038
	1892—Pass	115,478	8	4	1	14,435	28,870	115,478	8,883
	1893—Frt.	217,027	6	5	4	36,171	43,405	54,257	14,468
	1892—Frt.	222,292	1	1	2	222,292	222,292	111,146	55,573
Div. J.	1893—Pass	175,894	9	6	3	19,544	29,316	58,631	9,772
	1892—Pass	118,430	8	2	4	14,804	59,215	29,608	8,459
	1893—Frt.	133,196	2	9	2	66,598	14,800	66,598	10,246
	1892—Frt.	149,218	6	7	2	24,869	21,316	74,607	9,947

Div. K	1893	Pass	25,806	1	4	8	25,806	6,347	8,485	8,163
	1892–	Pass	14,[illegible]	2	0	0	7,290	....	....	7,220
	1893 –	Frt.	17,915	1	0	1	17,915	....	17,915	8,968
	1892	Frt.	20,426	4	0	5	5,107	....	4,085	2,959
Total, Divs. H to K.	1893	Pass	313,800	18	12	12	17,433	26,150	26,150	7,471
	1892-	Pass	248,917	18	6	6	13,797	41,391	49,869	8,564
	1893	Frt.	308,138	9	14	7	40,904	26,396	52,591	12,271
	1892	Frt.	391,331	11	8	9	35,680	48,991	43,548	13,998
Grand Total, All Lines.	1893–	Pass	915,187	37	54	87	24,735	16,948	34,785	7,149
	1892–	Pass	914,401	45	91	96	20,320	29,497	35,169	8,965
	1893–	Frt.	1,536,705	48	69	96	32,431	22,561	59,878	10,866
	1892–	Frt	1,714,715	60	108	86	28,579	16,811	47,631	8,660

PROCEEDINGS OF SOCIETIES.

Meetings of the Central Railway Club.—The Secretary of this Club announces that the meetings of this organization will be held in Buffalo, on the *fourth* Wednesday of January, March, April, September, and October, 1894.

Proceedings of the Engineers' Society of Western Pennsylvania.—At the regular meeting, held on September 16, there was a discussion of papers on Gas and Gas Producers, and the Effect of Suddenly Applied Loads of Iron and Steel, which were read at the June meeting. There was also a paper by Mr. E Hyde describing a water-tube safety boiler. The general design of the boiler will place it in the upright class, with a central water flue extending from the base below grates to the crown-sheet and entering the sides of this flue somewhat above the grates. In the drawings illustrated the crown sheet was located at about one-third the distance from the top of the boiler toward the base. The boiler, as shown, was arranged for the use of waste heat from a heating furnace, though should it be desired to fire direct, it would be merely necessary to remove the tile from the grate-bars and place a few bricks in the furnace flue to render it at once a direct fired boiler.

Engineers' Club of St. Louis.—At the meeting of the Club on November 15 Professor W. D. Potter read a paper on Progress of Smoke Abatement in St. Louis. The paper detailed the work which had been done by the Citizens' Executive Committee on Smoke Prevention, and gave a *résumé* of the devices which had been presented for accomplishing that purpose. Only three, however, had been tested—the Hawley down draft, the Boileau, and the zigzag grate bar. About 50 different devices for preventing smoke are in use in St. Louis, and some have received quite an extensive application. The steam jet principle is used in many, down draft in others, and the coking arches in some. There are some so-called combustion powders or compounds advocated, which are to be added to the coal before or during use. These usually consist of about 25 per cent. of niter with salt, sulphate, or carbonated soda, carbonate of ammonia, etc., which are supposed to improve the combustion, prevent smoke, and slag the ashes. They are valueless, however, as the amount of niter is too small to do any good, only 3 lbs. of powder being used, while the trouble with the ashes generally is that they are already too fusible, hence clinker on the grate bars. The work of the committee has resulted in creating a demand for a better design of boiler and greater care in their operation. More care is also being exercised in selecting fuels. The steam jet principle is usually effective in preventing smoke, but it is generally at a slightly increased consumption of fuel. One case was cited where an economy of 18 per cent. had been obtained, with a steam jet where a bed of 15 in. was carried on a hard worked boiler, though when the thickness was increased to 20 or lessened to 8 in. there was a loss in economy and capacity; that the down-draft type was not only effective in preventing smoke, but increased the efficiency and economy of the plant, and that 40 to 45 lbs. of coal per square foot of grate surface, with a good draft, or 50 lbs. with strong draft, could be burned on down-draft grate bars. The Wabash Railroad is successfully preventing smoke on its locomotives by a combination of the steam jet and baffle arch, the latter doing away with the excessive noise of the jet. A new down-draft device has also been brought out in London, England, for domestic stoves and ranges. It is quite successful, and promises to solve the smoke question for dwellings, but where smokeless fuels like coke, anthracite, oil, and gas are available, they not only prevent smoke, but are much cleaner. Crushed coke was stated to be but little more expensive than coal. In the discussion which followed it was stated that the extra expense of adding a down-draft device to a 100 H.P. plant is about $800, while the economy obtained is about 23 per cent. in fuel. It was also claimed that no ordinary grate bars would satisfactorily prevent smoke after long periods where the care of the firemen had to be depended upon, no matter how slow the rate of combustion.

PERSONALS.

Messrs. Paschke & Kelley, Civil Engineers, announce that they have opened an office in Room 9, World Building, New York, to do general engineering work. Extensive experience in Spanish-American countries and a knowledge of their languages and customs will, they think, enable them to cover an entirely new field in their occupation. They hope to be of especial service to corporations, capitalists, and engineers who desire examinations for or superintendence of structures in foreign countries.

OBITUARY.

Edward Martin.

Edward Martin died at Red Hook, N. Y., on December 8, at the age of 83 years. He was a civil engineer by profession and had laid out many railroads in this country. He located the Hudson River Railroad from Albany as far south as Hyde Park. At one time he was Superintendent of the old Galena & Chicago Railroad, and was the first President of the Rhinebeck & Connecticut Railroad. The first engine that ever drew a train of cars in America was put in order by him. He was noted for his philanthropic deeds, and had largely contributed to church work in his native town.

Manufactures.

A GLASS OIL-CUP FOR DYNAMOS AND GENERAL ENGINE BEARINGS.

The cup herewith illustrated is provided with an "index" device for regulating the flow of oil, and an indicator-arm turning on the lid to mark the notch giving the desired feed. When desired the feed can be instantly turned off, and on again, by replacing the index lever in the notch of the indicator-arm. When the index-arm is closed the lever can be left to stand up out of the notch, thus acting as an indicator to show from a distance that the feed is shut off.

As is often the case, where a number of cups require different feeds, especially before starting engine, when an extra amount of oil is wanted, this can easily be accomplished with the "Crown," without losing the original feed, by simply moving the indicator-arm a few notches to the right, and when the established feed is again required it is only necessary to replace same in the index slide, which marks the established feed.

These cups are all made of cast brass, handsomely finished, and are heavy and durable. The oil will not leak out between the brass and the glass parts, as is the case with all ordinary spun brass cups.

Where a strictly first-class cup is wanted—one that can be relied upon—the "Crown" is recommended. Wherever they have been put in use they are giving the very best of satisfaction. They are made in eight sizes, holding all the way from ⅛ to 18 oz. of oil.

Besides the "Crown," this Company makes even other styles for various purposes, all of which are fully described and illustrated in a catalogue, which will be mailed to any address upon request.

These goods are manufactured by the Lunkenheimer Company, of Cincinnati, O.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

Formerly the RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

The American Railroad Journal, founded in 1832, was consolidated with Van Nostrand's Engineering Magazine, 1887, forming the Railroad and Engineering Journal, the name of which was changed to the American Engineer and Railroad Journal, January, 1893.

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EDITORIAL NOTES.

THE instability of warships has probably been a matter of growth and evolution, like many other things. The desire to raise the firing-point of heavy guns as far above the water-level as possible, the use of heavily armored turrets, and the increasing weight of the military masts with their protected tops have so raised the center of gravity of the vessel that the stability has been sacrificed. It seems hardly proper to put a gun on a platform which has such a tendency to roll that accurate aiming is impossible, merely for the sake of a few feet of elevation above the water-line.

THE iron car has had a long pull and a hard pull in getting itself admitted into the favor of railroad men, but the time seems to be near at hand when it will be regarded as an essential part of the rolling stock. Heretofore the great expense attending its construction and the more than doubtful saving in maintenance has kept it out of the race. But such reports as those furnished by Mr. Joughins, on the cost and repair account of the iron cars which he has had in service, will go far toward removing prejudice from the minds of the men in charge of the car departments, and opening the way for the general introduction of these cars for some kinds of freight.

THE newspapers have been commenting very widely of late on the practice of paying speed premiums on war vessels. While the practice was certainly one to have been commended when it was first introduced by Secretary Whitney, as American builders did not know what they could do, it does seem that now if the Government wants a 20-knot vessel it should contract for it direct, and not invite bids for an 18-knotter with a privilege granted to the builder of making the speed 20 knots and get a premium of $200,000. It certainly favors the builder and allows for laxity, for we take it for granted that a 20-knot speed is wanted when 18 is asked for. American builders do not need this coddling any longer; they know what they can do, so the reason for the premium system appears to exist no longer.

THE instability of some of the warships of the English and United States navies has been brought prominently to the attention of the public during the month that has passed. The Naval Board have reported against two of our own vessels, and recommended heroic measures for the remedying of the difficulty. The English vessel *Resolution* has, according to all reports, had a narrow escape from capsizing in the Bay of Biscay. The question naturally arising from these two events is, "Who is responsible?" To this there seems to be no answer forthcoming. Professional courtesy reigns supreme, and the designer, whoever he may be, is sheltered behind this cloak. Perhaps no good would be accomplished by making this name public, but the Navy Department should take very good care that he designs no more ships.

THE probability is that the conventions of the Master Car-Builders' and Master Mechanics' Associations, which are to be held at Saratoga in June, will be a notable success from the standpoint of the exhibits which are to be presented. Already the committee in charge of the local matters is making preparations for the installation of exhibits, and it is announced that there will be a line of shafting in motion from which power can be taken for driving machine or other tools. This is a step in the right direction, and one that will be appreciated by those who have made individual attempts in time past to provide a means for operating machinery. The results obtained have been so unsatisfactory that it is very rarely that a second attempt has been made, but with a line of shafting driven by a suitable engine there will undoubtedly be a fine exhibition of machinery in motion.

MEETING OF MEMBERS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

ON another page we give a report of the proceedings of a first meeting of members of the Society of Mechanical Engineers for the discussion of subjects pertaining to their occupation. This meeting to a certain extent was an experimental one, and was held as a sort of sequence to a discussion which was first commenced in these pages. The meeting was generally considered a success, and the encouragement offered to its projectors and those in attendance will lead to a continuance of the meetings, and it is hoped will ultimately make them a permanent feature in the proceedings of this Society, or rather of its members. That such meetings may be made sufficiently interesting and profitable to induce members to attend them was shown in this first assemblage, and the discussion of the subject which was presented. The attendance was very good, the hall of the Society being nearly filled. The regular date for holding the meetings is the evening of the second Wednesday of each month. This date will fall on February 14, when the same subject that was considered at the last meeting—the Development of Stationary Engines as illustrated by those exhibited at the Columbian Exhibition in Chicago—will again be discussed. Mr. Charles T. Porter will introduce the subject, which will afterward be open for general discussion.

As will be seen from the introductory remarks of the chairman of the Committee in charge of the meetings, they will be conducted in a very simple way. As far as practicable it is the purpose to ignore "cranks" and mathematics. At least some of the members of the Committee are of the opinion that engineers should use mathematics as they say their prayers—that is, it should be done in private. The Committee will aim to make these meetings occasions for presenting the ripest fruits of the experience and knowledge of the members of the Society and their associates.

A CRITICISM FROM HEADQUARTERS.

In the announcement of our purposes and intentions for the year 1894, which was published in the December number of The American Engineer, in speaking of our monthly record of accidents to locomotive engineers and firemen, it was said that "its object is to call the attention of railroad managers especially, and the public generally, to the terrible amount of pain and agony, the suffering and bereavement, and the sacrifice of life and limb which goes on daily on our railroads, almost unnoticed and certainly unheeded. We hope to awaken public indignation and to arouse railroad managers to the exertion of some intelligent effort to diminish this sacrifice of life, and the inexpressible torture to which men are often subjected for no other reason than that they have faithfully performed their duties."

This paragraph has been the subject of some criticism, and a railroad officer writes, asking whether we "have any idea that the attention of railroad managers will be any more effectually called to these matters than it now is in their daily routine of business?" He also inquires whether we "know of any railroad manager who is so hardened that he is not willing to consider and adopt any practical device for the purpose shown?"

The criticism is a fair one, and we have therefore read over our quoted paragraph several times to see wherein, if at all, it should be altered. Reflection has suggested the change of one word. If the paragraph were unwritten or unprinted, the word "more" would be substituted for "some." As it now reads, the implication is that railroad managers do not exert *any* intelligent effort to diminish the sacrifice of the lives of engineers and firemen. That is unjust. If we were shaping that sentence into language anew, it would be said that "we hope to awaken public indignation and to arouse railroad managers to the exertion of *more* intelligent effort to diminish this sacrifice of life."

To the question of our correspondent about railroad managers, we feel compelled to answer that we do know of railroad managers who are unwilling to adopt practical devices for saving life. The recent accident on the Delaware, Lackawanna & Western Railroad is a melancholy example. It would not be necessary to go far to find others, and it has happened over and over again that only the sad teaching of calamity, the force of public opinion, or the strong arm of the law has made managers willing to adopt practical devices. It is not so many years ago that it required repeated accidents on a very prominent railroad, which carries passengers to and from New York, to adopt air-brakes on its trains, and on the same road it required an awful calamity, which came in the form of a personal bereavement to those in authority, to induce them to realize the need of block signals on that same line.

Now this reluctance to adopt practical devices is not because railroad managers are "hardened," as our correspondent expresses it. They are not. Some of the most tender-hearted and sympathetic persons we have ever known—and among them is our correspondent—have been railroad managers, and it is safe to say that they all realize their responsibility to an extent that is impossible to those who often criticise them hastily. But the motives of action of a railroad manager, like those of most other human beings, are very complex, and have added to them all the intricacies of the organization over which he exercises control. Life and all its duties and perplexities would be very much easier if we could all know exactly what we ought to do. That word "practical," which our correspondent uses, may embrace a great many of our difficulties. We encounter it constantly in our personal, our social, our business, and our political relations. To know what is practical and what is not is often our great difficulty. Even in shaping these few sentences, the question is constantly arising whether a given form of sentence or selection of words is practical—that is, will it express clearly what is in the writer's mind? On the Delaware, Lackawanna & Western Railroad the President and General Manager apparently don't think that block signals are practical. In the early days of railroading in which they were trained such signals were not essential, but gradually year by year traffic increased, until almost unconsciously a condition of things has been reached under which the trains cannot be moved safely without such signals. In the mean while, these gentlemen have been growing old, and with advancing years an aversion—which comes to all of us—to adopting new ideas has gradually taken possession of them, and the avenues to their minds through which new ideas and conviction should find an entrance have been contracted.

The fact is that "practical" devices for preventing accidents are not always obvious, and this is particularly the case with the class of accidents which happen to engineers and firemen. They have not been studied with a sufficient amount of care to indicate how they may be prevented. When passengers are killed or injured it attracts public attention, and there is an investigation of some kind, with suggestions for prevention in future; but when an engineer or fireman is killed, it is accepted as a necessary concomitant of the operation of a railroad.

One of the objects for which our monthly record of accidents to engineers and firemen is published is to bring them together so that they can be analyzed and classified, and we have entertained the hope that from these records it might be possible to discern the causes of different kinds of casualties, and thus see in what direction a remedy should be sought. That there is a constant sacrifice of the lives and limbs of engineers and firemen on our railroads no one doubts. Why is it not prevented? Because no practical way is apparent to our managers of doing it. Who is prepared to say that prevention, or at least mitigation, is impossible? Our purpose is to indicate the means, if that can be done, and to stimulate other people to do so, if that be possible.

It may not be amiss to suggest certain directions in which railroad managers might look for means of preventing such accidents. Attention has been called in these pages many times to the insufficiency of the steps on locomotives and tenders, and it is a gratification to be able to say that several of the builders of locomotives have acted on these suggestions, and that now the Schenectady and the Brooks and other locomotives have large, liberally proportioned steps, conveniently located, and easily accessible. There are, however, thousands of locomotives running with steps which invite accident, and we have never heard of a railroad manager ordering one of them removed and a better put in its place.

Our accident reports bear frequent testimony of the occurrence of that class of accidents in which engineers and firemen are scalded. Now, an ordinary locomotive boiler has more holes in it than the top of a pepper-box. These are intended for and receive the various cocks, gauges, valves, and other attachments which are essential to the operation of the boiler and the locomotive. In accidents these are likely to be knocked off, which releases the steam or hot water, and thus men pinioned in a wreck are often slowly or rapidly scalded to death, or tortured so that death would be preferred. Now, is there anywhere on any road or in any locomotive shop any effort being made to reduce the risk to this class of accidents? There are, we know, several kinds of check-valves manufactured, and are being introduced to a limited extent, which are located inside of the boiler, so that if in a collision the check-valve or its case is broken off the hot water and steam cannot escape. The terrible accident which occurred on the Pennsylvania Railroad about 12 or 15 years ago at Pi tsburgh will be remembered. In this a train from Pittsburgh ran into the rear end of a stand-

ing local train. The locomotive telescoped into the rear car, which was filled with passengers. In doing so the check-valve and its case was broken, and the contents of the boiler were discharged into the car, scalding a large number of passengers to death. The inside check-valve has been designed to guard against such accidents, and has been pronounced a "practical device" for the purpose, yet it is quite safe to say that it has been adopted on comparatively few roads. That it would be possible to protect some or all of the other openings in a boiler by similar means, or by skillful designing largely diminish the number of openings required, we think is a safe assertion; and yet who is doing it?

In many of the recent locomotives, too, the space in which the engineer and fireman must work is so contracted and inconvenient that no human being should be asked to occupy them. The men are often so hedged in that escape is impossible in the face of impending danger.

Not an unusual cause of injury to the men on the engines in accidents is that in collision or derailments the tender is forced or jumps up on the foot-board of the engine, or the tank breaks loose from its fastenings, or if it does not, the coal is discharged as from a catapult on to the unfortunate men on the engine. Now it is submitted that it would not be a difficult mechanical problem to devise some means which would hold the tender-frame in its place, and prevent it from mounting on the foot-board of the engine. Mr. Blackstone, on the Chicago & Alton Railroad, has for years used a device of that kind on his passenger cars. It is effectual and not expensive and therefore practical, and yet it has never been applied to engines and tenders.

To get a realizing sense of the danger to which the men are exposed on locomotives, let any one imagine that the tank and its contents and the coal on the tender, of an aggregate weight of, say, 50,000 lbs., was suspended by a frail attachment at a height of, say, 50 ft. overhead. The imminence of the danger is apparent, if the attachments which hold this weight should break. The velocity which this weight would acquire in falling 50 ft. would be just about 40 miles per hour. Now when running at that speed on a locomotive, the momentum of the tank and coal would be just as deadly, if the engine should be suddenly stopped by a collision or derailment, and the attachments of the tank to the tender-frame should break, as it would be if they fell on the engineer and fireman from a distance of 50 ft. above them. All that is interposed to the occurrence of such a disaster, in cases of collision, is the fastenings of the tank to the frame of the tender. It will require a good deal of temerity for any one to say that these are as strong as they easily might and should be made.

It is not believed that railroad managers are "hardened," nor that they are indifferent to the safety of their men but, like the rest of mankind, they often are not able to see or to know what measures are "practical," and the mental inertia which weighs down the whole human race exerts its force on them as it does on all the rest of us. To bring about a reform of any kind a great deal of intelligent "hustling" is always demanded, and before we can set things right it is important to know to what extent they have gone wrong. This service, it is thought, our reports of accidents to engineers and firemen may perform.

NEW PUBLICATIONS.

The Electric World has also assumed a new suit of clothes with the new year. Its size is now 9½ × 13 in., which is much more convenient than the old form. It may be noticed that when the fickle goddess smiles on our cotemporaries, they immediately try to emulate the good example which The American Engineer has continually aimed to establish. Fellow-cotemporaries, we are now all three of a kind. May the mantle of peace and prosperity be upon all of us.

The Tradesman, published semi-monthly in Chattanooga, comes to us in a new form which is now almost exactly the size of The American Engineer. It, *The Tradesman*, has all the appearances of prosperity. Whether its proprietors are correspondingly happy we have no means of knowing, but it seems as though they ought to be.

A Thousand-Mile Ride on the Engine of the Swiftest Train in the World. *From New York to Chicago in the Cab of the Exposition Flyer.* By Cy Warman, formerly engineer on the Denver & Rio Grande Railroad.

The above is the imposing title of an article in *McClure's Magazine* for January. It is written in the current newspaper style, which is a little hysterical. It is illustrated with engravings of various kinds one very excellent one of the reproduced *De Witt Clinton* and train, which has been published so much and so often. The celebrated 999 and her train is also very well engraved. Not so much can be said of some of the portraits. The writer of this notice is well acquainted with Mr. Buchanan, Superintendent of Machinery of the New York Central Railroad, and he, the writer, can bear personal testimony that his hands are not as big and his head is not as small as they are represented in his portrait in this article. The kind of pictures which newspapers publish of people make one long for an extension of the copyright law, so that we may have our faces copyrighted and thus prevent such misrepresentations being published.

The article is popular and readable, which is about all that can be said in its favor.

On Formulas for Pile-Driving. By Charles Haynes Haswell, M. Inst. C.E. For nearly 40 years a copy of "Haswell's Engineers' and Mechanics' Pocket-Book" has been a companion of the writer. This copy was published in 1855, and is well worn and soiled. It opens of itself at the places which have been oftenest referred to, among these being the tables of areas and diameters, which are nearly worn out. The author of this book is now 84 years of age, and may be met any morning walking to his office with a vigor and elasticity which some of us who are a generation younger may envy. It will, perhaps, come as a surprise to some of our readers to have a new paper by this same author. The little pamphlet before us is a paper of six pages submitted to the Institution of Civil Engineers. In it he has attached the formulæ of other writers, and has evolved one of his own. Many of us will hope that Mr. Haswell may write still another paper and give in it the formula for perpetual youth, which he apparently has discovered.

Notes on the Testing and Use of Hydraulic Cement. By Frederick P. Spalding, Assistant Professor of Civil Engineering, Cornell University, Ithaca, N. Y. Andrus & Church, Ithaca, N. Y. 6¾ × 4½ in., 108 pp.

The notes embodied in this little book, the author says, "were designed for use as a text in a short course of instruction, as well as to serve the purpose of a handbook in the laboratory." It consists of three chapters on the Nature and Properties of Cement; Cement Testing; The Use of Cement and the Literature Relating to Cement.

A new book is somewhat like, and in fact is a new acquaintance, and the reader is influenced by it somewhat as he is when he meets a stranger. Some people and some books keep us at a distance, while others at once seem to take us into their confidence. The book before us is one of the latter kind. The author begins by telling the reader in the simplest and clearest way what hydraulic cement is, describes its properties, how it hardens or sets, and the peculiarities of this process under different conditions. The second chapter describes the object of testing it, the qualities, such as weight and specific gravity, fineness, rate of setting, tensile strength, soundness, chemical ingredients, etc. The methods of making such tests are also described in an admirably clear style, which the reader follows without an effort, and is as much entertained, and a great deal more instructed, than he is in reading a newspaper article. The third chapter tells us of the use of sand and water in mortar, mixing mortar, concrete, and lime and cement, the effects of freezing on mortar, its porosity, permeability, expansion, and contraction.

The last chapter gives a list of literature relating to hydraulic cement in English, French, and German. The author says that only such papers have been included as seem to possess some definite value for purposes of research. This feature of the book is a very valuable one.

Altogether these "notes," which Professor Spalding has given to the public, may be highly commended, and it may

be said of them that he has "so presented his ideas that they may be apprehended with the least mental effort," instead of clouding them in circuitous phrases and intricate mathematics, as seems to be the fashion of late in the writing of technical books.

Elementary Lessons in Steam Machinery and the Marine Steam-Engine, *with a Short Description of the Construction of a Battleship.* Compiled for the use of junior students of marine engineering, by Staff Engineer J. Langmaid, R.N., and Engineer H. Gaisford, R.N. New edition, revised and enlarged. London and New York: Macmillan & Co. 8¾ × 5¼ in., 261 pp.

These "Elementary Lessons," the authors tell us, "were prepared for the naval cadets in H. M. S. *Britannia*, and represent a systematic course of simple instruction preparatory to a more thorough study of the whole subject."

Under the guise of this rather formidable title and pretentious announcement, the authors and publishers have given the public a lot of what may be called engineering twaddle, and if this is the basis, as the authors say it is intended to be, of the instruction of the naval cadets in H. M. S. *Britannia*, they are deserving of sympathy.

As an example of the sort of intellectual food prepared for them, the following is an example: "In constructing steam or other machinery, measurements are usually made in *feet, inches, and fractions of an inch*, and these measurements must be very accurate and exactly adhered to." Are the cadets in the British Navy in the habit of thinking that steam machinery is measured by the yard, furlong, mile, or French meter?

Again it is said: "Cylindrical surfaces are measured by gauges, 'ring,' and 'plug,' similar to those represented in fig. 1." This is not true; such gauges are not used for measuring cylindrical surfaces, but only as standards of reference, from which the correctness of the measuring tools or instruments may be verified.

"Truly flat surfaces," it is said, "are insured by the use of 'straight edges' and 'surface plates.'" If the authors had here explained how to use straight edges in order to make a flat surface, and how the inaccuracies in one flat surface can only be corrected by comparing or testing it with *two* others, they would have been giving the cadets valuable information.

The book hardly merits serious review. To tell a student that "a screw may be defined as a cylindrical bar on which has been formed a helical projection or thread," is giving an explanation which is harder to understand than the thing explained.

The book might, perhaps, somewhat coarsely, be described as mechanical hash—that is, it is a lot of fragments which have been thrown together without system and often, apparently, without purpose. The only features which can be commended are the printing and engraving. Both of these are excellent. Apparently the authors procured the services of a good mechanical draftsman, who supplied the illustrations. It is to be regretted that he did not write the book.

Maps of the United States Geological Survey. We have received from Mr. J. W. Powell, Director of the United States Geological Survey, 12 sheets of maps representing that part of the State of New York and a part of Connecticut adjacent to the Hudson River. These maps are drawn to a scale of 1-62.500. or a little more than an inch to a mile. They are approximately 17½ × 18 in. in size, so that each map represents an area of about 227¼ square miles. The maps are drawn with the care and have the beauty which is characteristic of the work which comes from this department. The streams and other bodies of water are represented by blue lines, the topography by contour lines printed in brown or bronze-colored ink, and the roads, boundary lines, and lettering in black. They are exquisite examples of this kind of work, and what is of more importance, their correctness is authenticated by the United States Geological Survey and the State Engineer and Surveyor of New York. These maps are made by the co-operation of the Department at Washington and the State of New York, Congress and the State Legislature having each made an appropriation to meet the expense, and we are informed that the same thing has been done in the States of Connecticut and New Jersey.

Most of the sheets before us were engraved by the United States Geological Survey, one by Evans & Bartle, and the others by Julius Bien & Co., of New York. All the maps were made under the authority of the Director of the United States Geological Survey, J. W. Powell, Martin Schenck, Chief Engineer of the State of New York, Henry Gannett, Chief Topographer, H. M. Wilson, Geographer, in charge. The topography of different maps was by Frank Sutton, J. H. Jennings, G. L. Johnson, E. B. Clark, J. W. Thom, Robert Muldrow, R. D. Cummin, and W. M. Beaman. The triangulation was from the United States Coast and Geodetic Survey, New York State, and New York Aqueduct Commissioners' Surveys.

New Atlas of the State of New York. In connection with the previous notice it may not be out of place to mention that Messrs. Julius Bien & Co. have in contemplation the publication of an atlas of New York, which will fairly represent the greatest State in the Union, which, it may be added, no atlas yet published has ever done. We had the privilege of inspecting some of the advance sheets of this map, and think we are authorized in confirming the publishers' statement that it will be the most complete atlas of this State ever published.

It will contain a general map of the United States, showing State boundaries, principal cities and towns, river systems, railroads, etc. A general map of the State, showing county boundaries, railroads, canals, and all important cities and towns; also the new proposed State Park in the Adirondacks. A temperature map, showing mean annual temperature. A rainfall map, showing average annual rainfall. A population map, showing density of population. A hypsometric map, showing elevations. Also a large map showing original land grants, patents, and purchases throughout the State. These will be followed by detailed maps of each county on large scale, showing city and township boundaries, post-offices and villages, public roads, lakes, rivers, railroad lines and stations, with altitude where obtainable. The lot lines of the original land patents in the State will also be given (where obtainable), from the latest authentic data, most of which have never before been published. An alphabetical list of counties, townships, cities and villages, with population from last census, will be given, and all railroad stations, telegraph, express and post-offices will be appropriately designated.

"The Iron Founder" Supplement. *A Complete Illustrated Exposition of the Art of Casting in Iron.* Comprising the Erection and Management of Cupolas, Reverberatory Furnaces, Blowers, Dams, Ladles, etc.; Mixing Cast Iron; Founding of Chilled Car-Wheels; Malleable Iron Castings; Foundry Equipments and Appliances; Gear Molding Machines; Molding Machines; Burning, Chilling, Softening, Annealing, Pouring and Feeding; Foundry Materials; Advanced Molding; Measurement of Castings; Wrought Iron, Steel, etc. Also the Founding of Stations; the Art of taking Casts; Pattern Molding; Useful Formulas and Tables. By Simpson Bolland, Practical Molder and Manager of Foundries. 7¼ × 5 in., 392 pp. New York: John Wiley & Sons.

As indicated by its title, this book is a supplement to the author's earlier book, "The Iron Founder." The supplement begins with a chapter on the Evolution of the Iron Founder's Art, which is followed by one on Blast Blowers, which gives a description of the several kinds of blowing engines used in the past, as well as some of those in use at the present day. Among the latter the Sturtevant, the Mackenzie, and the Root blowers are illustrated and described. The chapter on Mixing Cast Iron, with the description of its chemical composition, it is feared, will not be of very material help to practical founders. Underlying the descriptions the author seems to entertain the idea that mixing iron is a great mystery, and the reader is left in doubt whether it has all been revealed to him. The chapter on Foundry Cupolas is very clear, but might have been fuller. A defect in the book is that no titles are printed with the engravings. In looking through a book of this kind, the "looker" often wants to know what a given illustration represents without reading the whole description of it. Titles to engravings are a great help in doing this. In these days of overmuch literature, the number of people who look through books and *don't* read them is much larger than those who *do* read them. The demands of the former class ought to be regarded. In the chapter on Reverberatory or Air Furnaces their characteristic features are not sufficiently explained. A little elucidation of the construction and operation of each would be a great help to students who are not practical founders.

The subjects treated are: Casting One Hundred Tons of Iron, showing the construction and use of the necessary equipment for pouring heavy castings, dams, receivers, air furnaces, ladles, with table of capacity, runners, etc.; Castings, how to obtain their measurement and secure their weights. In this latter chapter there is a long dissertation on arithmetic, men-

suration, tables of weights, and strength of different materials which ought not to have a place in the body of the book. If given at all, it ought to have been placed in an appendix.

A chapter on Foundry Appliances includes testing machines, block and plate methods of molding, gear molding by machinery, and a description of some modern molding machines. A reviewer cannot help but see what an excellent chance the author missed of giving a sort of primer on the strength of cast iron, how to test it, its behavior under test, and the influences which effect its strength. The engravings in this chapter, especially those of molding machines, are very bad, and the descriptions of them inadequate. Chains, Beams, Slings, Hooks, Ropes, etc., Pouring, Flowing-off, and Feeding Castings are described in much detail, and the reader will be richly repaid for the time given to this part of the book. In the remaining portion of it the following subjects are discussed: Studs, Chaplets and Anchors, High Class Molding, Sectional Molding for Heavy Green Sand Work, the Founding of Statues in Iron and Bronze. This last chapter contains an engraving of a statue of Venus which makes one doubt whether she was the goddess of beauty. If she resembled the engraving, she was certainly not a beautiful goddess.

The author gives us dissertations on the art of Taking Casts, Pattern Modeling in Clay, the Making of Malleable Iron Castings and Chilled Car-Wheels, directions how to Repair Broken and Cracked Castings, and ends with descriptions of the qualities of various materials used in foundry work and various useful receipts.

The book has the merits and the defects of literature which is produced by "practical" men. It is full of information relating to the difficulties encountered in doing foundry work, but in other directions, as has been indicated, the treatment of the subjects is inadequate. On the whole, it may be highly recommended to those who want information concerning the details of foundry practice. The printing and paper are only "fair to middling;" some of the engravings are excellent, others poor, and still others positively bad.

TRADE CATALOGUES.

Valentine & Co. have sent us a pocket memoranda tablet with calendar. It is bound in leather with celluloid covers, and is designed in the admirable style which characterizes all the advertising devices of this house.

The Link-Belt Machinery Company have issued a little pocket edition of a pamphlet describing the Ewart Friction Clutches which they manufacture. It is well illustrated with good engravings and descriptions of the clutch.

United States Metallic Packing Company, of Philadelphia. 51 pp., $4\frac{1}{2} \times 7$ in. Illustrated. Describes different kinds of packing made by the Company, with good illustrations showing sectional views of it, and a long list—which occupies 40 pp.—of users of it.

The Buckeye Automatic Car Coupler Company, Columbus, O. 25 pp., $6 \times 8\frac{1}{2}$ in. Illustrated. Describes coupler, shows dimensions and gauges, form and method of construction, gives specifications of tests, describes material used in manufacture, and gives reports and illustrations of results under Master Car-Builders' tests.

BOOKS RECEIVED.

Bureau of the American Republics. Bulletin No. 61, *Uruguay.* Washington, D. C.

Electricity up to Date, for Light, Power, and Traction. By John B. Verity, M. Inst. E.E. New York: Frederick Warne & Co.

Eleventh Annual Report of the Board of Railroad Commissioners of the State of New York for the Year 1893. Volume I. Albany.

Seventh Annual Report of the Interstate Commerce Commission: December 1, 1893. Washington: Government Printing Office.

The Electric Transmission of Intelligence and other Advanced Primers of Electricity. By Edwin J. Houston, A.M. New York: The W. J. Johnston Company, Limited.

The Cincinnati Southern Railway. A Study in Municipal Activity. By J. H. Hollander, Fellow in Economics, Johns Hopkins University. A memorial of Lucius S. Merriam, Ph.D. (J. H. U.). (Johns Hopkins University Studies in Historical and Political Science.) Baltimore: The Johns Hopkins Press.

The Correspondence School of Mechanics. A System of Home Study in Mechanics, Geometrical and Mechanical Drawing. This is a pamphlet of 56 pages describing the methods and course of instruction in this school, which is located in Scranton, Pa. Doubtless there are many students who are unable to go to a technical school and who will be glad to avail themselves of a course of study which they can pursue at home. The volume before us will give them information about the system adopted in the school which has issued this publication.

Fiber-Graphite Bushings for Hangers, Pillow-Blocks, Loose Pulleys, etc. Requiring no oil. The Link Belt Machinery Company, Chicago, Ill.

This little publication describes the merits of fiber-graphite, of which it is said "that by its use line shafting and journals of like kind may be run absolutely without the use of oil or other applied lubricant, at any desired speed and at pressures up to 50 lbs. to the square inch." Of such bearings the publishers say that "about 4,000 have been installed." Fiber-graphite is described as "simply the highest grade of lubricating plumbago, compounded with other materials in such a manner as to produce virtually solid graphite linings."

Many readers will probably read what is said in this publication with incredulity, but the Company issuing it are not given to making representations which they cannot substantiate.

AN EDITORIAL PERPLEXITY.

The following letter, addressed to the editor of this paper, was received through the mail a short time ago:

Dear Sire

I am very interesting over this Problem in yours Book from the January. This Problem it is right when you all this Questions in a answer and in a Drawing you got Part I. What is the circle? Part II Whe you make a straight line in a round line and a round bak in a straight line Part III How many Diameter you got in the Elipse or oval? Part IV Whe you finishet the Diameter out from the Elipse or oval. Please Mr you will send my bak on answer I give you over all an answer and a drawing.

Yours very trully

—— ——.

The meaning of this is as hard to make out as the explanations in some of the recent technical books.

TENDER FRAME, PHILADELPHIA & READING RAILROAD.

To the Editor of the American Engineer and Railroad Journal:

I notice in the December number of your Journal an article on Philadelphia & Reading iron tender frame, which contains some errors which I would beg leave to correct. First, the channels are not butted together on the center line, as stated, but on the sides, $33\frac{1}{2}$ in. from end. This is done for two reasons. The frame being but 90 in. wide makes the end sill or bent portion comparatively small, and therefore much easier and cheaper handled in smithshop than if side sills were bent at ends, as per your statement. All our old iron tenders had channels butted in center, but without proper bracing this became an element of weakness, and in repairing, instead of just putting in patches, we put in whole new ends and spliced same to sides with splice plates from 2 to 3 ft. from ends, as shown on engraving, and have had no trouble with this construction. We therefore adopted this in preference to the old construction on the new frame. This splice is also at a part of the frame which is not subjected to heavy transverse loads, as it is at or near the extremity of tank. In tension this splice possesses strength equal to other parts of frame.

The body bolster is composed of three pieces, the tension members being $\frac{3}{4}$ in. $\times$ 6 in., and the compression 1 in. $\times$ 15 in. The tension members being flanged at end are made in two pieces for convenience in smithshop. The compression

member, not requiring such difficult bending, is left in one piece.

You take us to task for the scanty diagonal bracing. I would beg leave to state that we have frames in service with bracing which is inferior to this, and we have no trouble. Furthermore, there is space allowed for a water scoop and necessary mechanism. If you examine into detail, you will also find that if bracing were extended it would be impossible to get it either in or out without tearing frame apart.

The old design of frames called for a number of holes through flanges of channels, and particularly was this the case where the bolsters crossed the sills. The consequence was that the sills would bend through these holes, for the very life of the metal was cut away. In the new design you will not find one hole in the flanges, except at such places where the channel is not subjected to an upward or downward thrust, or near the ends of the channels, where the strength is excessive.

When the channels are subjected to a load, you will invariably find the holes at or near the neutral axis of the beam. To accomplish this it became necessary to make some parts somewhat expensive. Notice the construction where the bolsters are fastened to center sills. The channels rest on projections from a cast-iron box or filling piece, to which they are bolted through the neutral axis. The bolsters are also bolted to this box, which extends ½ in. above channels, thereby taking away all possibility of bolsters and channels chafing on each other and cutting away the best metal if they should become loose.

At the front end it was possible to get in only one stiffening plate ½ in. thick. At the back end there are two, one top and one bottom. The brackets for bumper-blocks are bolted direct to the under plate. The bracket for back pulling casting is also bolted to same plate. In addition to the stiffening plates at back end there is also a filling casting between plates and between center sills, to which casting the plates and sills are bolted, thereby making a solid construction at back end.

These plates, both back and front, take the anchor-bolts which hold tank in position. The floor (not shown on drawing) is bolted to strips which are on inside of center sills and on outside of side sills, but which are not bolted to sills. It would, therefore, be possible after raising tank to take floor off in one piece. We deem the weight of tank and strips sufficient to keep floor from shifting in all ordinary service, and in case of a wreck its construction does not matter much.

READING, PA. E. L. MOSER, M. E.

MODERN LOCOMOTIVES.

To the Editor of THE AMERICAN ENGINEER AND RAILROAD JOURNAL:

The Midland Railway Company at Derby Works has just turned out a new express engine, No. 179, designed by Mr. S. W. Johnson, being the first of an order of 10 having several new features. Like the former engines of the class, it has a leading bogie and single driving-wheels of 7 ft. 6 in. diameter. The cylinders of the 179 class are 19 in. × 26 in., and inclined downward to the driving-axle. The valves are of the piston pattern worked by link-motion, and placed below the cylinders and inclined upward to the driving-axle. The boiler pressure is 160 lbs. per square inch.

No. 179 has been tried a few trips before being painted, and has given some wonderfully good results.

There seems every reason to believe that piston-valves placed under the cylinders will be a striking improvement, the very fact that they drain the cylinders of water is of the highest importance in practice. CLEMENT E. STRETTON, C.E.

LEICESTER, December 20, 1893.

THE INDUSTRIES OF CHEMNITZ.

To the Editor of THE AMERICAN ENGINEER AND RAILROAD JOURNAL:

Somebody was good enough to give me a marked copy of your very interesting magazine, THE AMERICAN ENGINEER AND RAILROAD JOURNAL. I read its contents, and cannot help complimenting you on style, stuff, and make-up. The articles, besides being well written, are nicely, neatly, and intelligently illustrated, the matter is of current interest, treated broadly enough for the layman, and detailedly enough for the technician; the magazine is a very convenient size, well printed and bound. I cannot comment on these things without complimenting their author. Merited praise is the hard worker's and just man's due. Intelligent men cannot be flattered. What I want to say here is that Chemnitz, this far inland Saxon city, the Manchester and Nottingham of Germany, illustrates as much as any city in the empire the striving, get-there spirit of the modern German.

In 1834—60 years ago—Chemnitz counted within her gates 21,137 people, to-day she has 150,000: 1834, 21,000; 1840, 23,500, 1846, 29,000; 1852, 34,000; 1858, 40,500; 1864, 55,000; 1871, 68,000; 1875, 78,000; 1880, 95,000; 1885, 110,000; 1890, 138,950; 1894, 150,000.

Chemnitz counts in the world's markets as Germany's textile center. Here is the home of hosiery and underwear. Last year (1892) there came into Chemnitz 13,668,951 lbs. of raw cotton, 9,231,439 lbs. of cotton yarn. There was sent out 1,612,778 lbs. raw cotton, 5,231,644 cotton yarn, and 16,056,-962 cotton and woolen goods.

Back in the forties Chemnitz began the manufacture of machines. During the decade that went out with 1850 she could count only 868 persons in her machine shops. One concern alone until quite recently employed 5,000, and to-day, in spite of dull times, has on its active pay rolls 3,500. One Company, the Saxon Loom Company, has sent out its 50,000th loom, and employs (A.D. 1893) 1,000 persons. Last year there was brought into the city 35,022,847 lbs. of raw iron; there was sent out machines and parts of machines, 48,501,000 lbs.

The companies that counted themselves fortunate in 1851 with $1,000,000 worth of work turned off, ran up a record last year of $7,500,000. In 1851, $750,000 measured the amount in textiles, last year and for several years past it has been above $17,000,000.

To-day (A.D. December 20, 1893) started the narrow-gauge trolley electric cars. Last year the company carried in horse-cars 1,500,000 persons, pocketing $40,000. The local banks turned over $234,069,335, one bank alone doing a business of more than $28,064,000. How was it possible to do all this and the "much more" that goes with it, but not interesting enough to take up your valuable space? First of all, because of energy, activity, enterprise, and intelligently directed advertising. One firm jumped from 230 hands in 1865 to 736 in 1888, from thousands to millions. How? By going to a place or country called the United States of America, lying in latitudes between Mexico's Gulf and our great lakes, and between longitudes west and east running through Cape Cod and the Golden Gate, and not only telling the people about his wares, but by getting American papers—for pay, of course—to "push them." By combining chemistry with practical workmanship, by putting the theorist, the scientist side by side with his trained workmen to watch every change. He got the secrets wanted, worked them up, and conquered. It is a combination that gives Germany her successes. Her schools, especially her real gymnasiums, the technical, industrial, and industrial art schools are doing it.

In business schools we beat the world, but in building up captains of industry, the man to make science the handmaid of inventive genius, to rob Nature, where no necessity demands, of her richest secrets, Europe leads. France, Switzerland, Germany, Scandinavia, Russia are ahead.

Get these schools for us, give them to Yankee genius, and the end will more than justify effort and expenditure. Out of these cities are sent trained men year after year. They go by rail, boat, or caravan into remote and near countries, they carry their country with them, they come back bringing orders or send them. These orders, no matter how small or large, are filled. Colors that cannot be obtained elsewhere the German plods till they are obtained. He may not be brilliant as his French rival, or inventive as our Englishman, but, better than both, he knows how to take up, persevere, carry out and combine. To tireless energy he unites a plodding perseverance, sure in time to bring their rewards.

J. C. MONAGHAN,
Consul.

CHEMNITZ, December 21, 1893.

THE RAILWAY SIGNAL QUESTION.

Editor of the AMERICAN ENGINEER AND RAILROAD JOURNAL:

The increasing number of serious collisions between railway trains has for some time elicited unfavorable comment respecting the management of our railways. It has been pointed out that in nearly every case the signaling apparatus was wretchedly primitive, or else that no signaling was used. Now, in point of fact, the science and art of railway signaling have been developed to a remarkable extent during the last twenty years. The English railways, being those which earliest saw large and congested traffic conditions, with ever-increasing demand for greater speed, have naturally borne the

brunt of practical experience in the signal field, and consequently American railway managers have not so soon become aware of the importance of this branch of the service.

The recent disasters have to a certain extent awakened a few managers to the increasing ratio of danger in proportion to the ever-increasing number and speed of trains, but in all probability no very general introduction of proper signal appliances will take place until the Government is compelled to exercise some kind of supervision of railroads to guard against the recurrence of such cycles of disasters, which will surely come in future if some such precautions are not taken.

Collisions between railway trains may be divided into three classes—viz. : 1. Rear end, or those which are caused by one train overtaking another occupying the same pair of rails. 2. Butting, or those caused by mistaken understanding as regards right of way in single track working. 3. Those caused by the wrong placement of switches, or the confliction of signals at junctions or grade crossings. It is generally conceded that the best way to guard against rear-end collisions is by the adoption of the block system. The managers of some roads have apparently understood this to mean simply the division of track into block sections of suitable length, and the employment of men at the block stations in telegraphic communication with each other.

Discipline and the use of properly constructed block-signaling instruments, operated under carefully formulated rules and regulations, have played quite a third-rate part. The comparative efficiency of the block system installed in this way, instead of as experience would dictate, may be illustrated by troops armed with gas-pipes, instead of rifle barrels. It is necessary to provide two safeguards for the aid of the signalman in the performance of his duty—viz. : 1. A carefully constructed block signaling mechanism ; 2. A carefully prepared set of rules and regulations dealing with the numerous contingencies of traffic, for the governance of all concerned with the safety of the line.

The New York Central and the New York, New Haven & Hartford railroads have recently equiped the most important parts of their lines with signaling, which in general, but not in detail, may be said to represent the crystalized result of all technical experience since railways were commenced.

The mere equipment of a railway with good signaling appliances is, as aforesaid, only half the battle, and it yet remains for our best railways to formulate proper and sufficient rules and regulations suitable to the divers contingencies arising from time to time in the movement of trains.

It was with a glimpse of this need in view that the American Railway Association recently appointed a committee to investigate the block signaling at present in use in this country, and to draw up a set of standard rules. Their attention is drawn to the fact that a very good basis for their work may be found in the rules drawn up by the Railway Clearing House of Great Britain.

Where but one track exists, necessitating the use of the rails in both directions, a most serious condition faces us—viz., the danger of a butting collision, through mistake as to right of track. The safeguard at present in use in this country depends entirely upon the proper transmission and understanding of telegraphic messages, sent to the crews of those trains which are to pass each other at passing sidings other than those indicated by the time schedule.

It is needless to point out that mistakes often occur in this message system, resulting seriously in almost every case. This grave danger appears to have been at last overcome by the aid of mechanism, molded to form by railway men of experience.

The new safeguard is known as the Interlocking Train Staff System. Each section of single track between two passing sidings is provided with two staff machines, one at each end. These machines contain a number of metallic staffs, and are electrically interlocked through the medium of line wires. No train or engine is allowed to proceed on any piece of single track until the engineman has received a staff. The issue of a staff from the machine is under the electrical control of the signalman at the remote passing siding, and the issue of more than one staff from any pair of machines at one and the same time is mechanically prevented.

The issue of a second staff for another train proceeding in either direction is dependent upon the rehousing of the free staff in one of the machines appertaining to that section of single track. It will be clear that as only one train staff can be out, therefore only one train can occupy any section of single track at one and the same time. It may be pointed out that this is simply a form of block working. Staffs are employed instead of or in addition to the line signals, because the authority to proceed does not depend on sight, but is tangible, in the form of a staff. Experienced men consider this extra precaution very advisable, on account of the dangers peculiar to single-track operation.

This brings us to a consideration of the means employed to guard against collisions at junctions or other points where switches occur and trains are required to cross the path of others at various speeds.

The interlocking system is invariably employed in such cases. This system consists of the concentration at a central point of all the signal and switch-operating levers of any system of switches. These levers are so interlocked with each other, by means of mechanical appliances, as to make the setting of conflicting switches and signals mechanically impossible. In addition to this all the facing switches are provided with a device known as a detector bar, which prevents the signalman from throwing the switch under a train and thus causing what is known as a "split."

When the block system is in use these interlocking plants are necessarily combined with the block working, and in fact become the most important block stations. All switching operations on the main tracks are thus carried on strictly under the block rules.

A. H. Johnson.

THE LOCOMOTIVE PROBLEM.

(Correction relating to the last solution.)

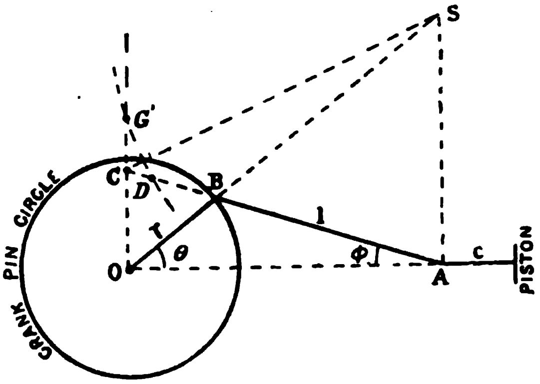
BY RENÉ DE SAUSSURE, C.E., ROANOKE, VA.

[The following paper is proffered by Mr. de Saussure as a correction to the solution given in our January issue. As the subject has now been most fully treated, we deem it advisable to close the discussion with this publication.—Ed.]

So many different solutions of this problem have been already published in the American Engineer (and the problem having of course only *one* correct solution), it is high time to settle this question and to proclaim which one of the solutions is correct.

I attempted in the last issue (January, 1894) to give a purely geometrical solution, employing the usual methods of the cinematical geometry ; this demonstration is correct, but I must confess that the conclusion I made then was wrong ; in other words, it is true enough that if the connecting-rod $\overline{AB}$ is produced until it meets at C the vertical line drawn through the center O, the speed of the piston is at any time proportional to the length $O\ C$, so that the maximum speed of the piston is attained when $O\ C$ is maximum. But I was not right in saying that $O\ C$ is evidently maximum when the connecting-rod is at right angle with the crank-pin radius, and I want to correct this part of the solution.

As the correct part of my last demonstration was purely geometrical, I propose to use only geometrical reasonments all the way through—that is, to find geometrically when the maximum of $O\ C$ occurs.



I have shown already that during an element of time, $d\ t$, the connecting-rod rotates around the virtual center S. If G' is the position of C after the time $d\ t$, and if we trace a circle passing through G', taking S as a center, this circle cuts the connecting-rod $A\ C$ at a certain point D, and D is the place where G' was before the element of time $d\ t$ had elapsed.

Reciprocally, if we knew the position of D we could obtain the next position of C by tracing a circle through D (S being the center) and taking its intersection with the vertical line $O\ C$. Now, when the angle $S\ C\ A$ is less than 90° (as shown

in the figure), the point G', thus obtained, will be above C; and when the angle $S\,C\,A$ is more than 90°, the point G' thus obtained will be below C.

But the maximum of $O\ C$ will be attained when the next position of C will be neither above nor below C (the maximum corresponding to a stationary position of C during the time $d\,t$). In order to fulfill this condition, the line $S\,C$ must be exactly at right angle with the connecting-rod $A\ C$.

The problem is now completely solved by a purely geometrical method, and I will announce it as follows:

"*The maximum and minimum speed of the piston happen for the two positions of the connecting-rod, in which this connecting-rod is at right angle with the virtual line S C.*" This is, I think, the first complete and correct geometrical solution of the problem.

This solution contradicts of course the one I published in the last issue, on account of the mistake made in the latter as above mentioned. I thought then that the maximum speed of the piston was attained when the connecting-rod was at right angle with the crank-pin radius; on the contrary, the connecting-rod must be at right angle with the line $S\,C$, and this condition prevents it to be also at right angle with the crank-pin radius $O\,B$, because $O\,B$ and $S\,C$ meet at point S, and therefore are not parallel.

I retract, then, all I have said concerning the prior analytical solution given by Mr. C. H. Lindenberger (in April, 1893), and apologize to him for having said that his solution was not right. On the contrary, the geometrical solution as given here confirms the result obtained by Mr. Lindenberger analytically, that the maximum speed of the piston does not correspond to the position where the connecting-rod is at right angle with the crank-pin radius, but is very near it (this is shown by the fact that when the connecting-rod is at right angle with $S\,C$, $S\,B$ is very near $S\,C$, the point S being very far).

I will say further that the solutions given prior to the one of Mr. Lindenberger are not correct; such is the case of the solutions given by W. H. Trethewey, Stratford, Ont. (July, 1892); Edward Walker, New York (August, 1892); Professor F. A. Weihe, Delaware College (January, 1893), and myself (January, 1894), who assumed that the piston has a maximum speed when the connecting-rod is at right angle with the crank-pin radius. I do not speak of the solutions assuming that this maximum occurs at the highest and lowest point of the crank-pin circle, as no scientific methods could lead to such a result.

Only two solutions published so far were correct, the one of Mr. Lindenberger and the one of T. B. Leeper, Lafayette College, Easton, Pa. (July, 1892). I must say I did not have time to go over the calculations of Mr. Leeper, but anyway his method is able to lead to a correct solution. But these two solutions are analytical, and require a pretty long demonstration; besides, they do not give any geometrical or analytical condition defining the position of the maximum in a general manner. They have to assume that the length of the connecting-rod and the radius of the crank-pin are given numerically, and so give only the solution for the case corresponding to these numerical data.

As I said above, the geometrical condition defining the maximum and minimum speeed of the piston is that the angle $S\,C\,A$ be a right angle, and this condition applies to any size of the connecting-rod and of the crank-pin radius.

NOTES AND NEWS.

New Battleships for England.—In a recent Admiralty report it is announced that 10 battleships, already provided for under the Naval Defense Act, will be completed early in 1894.

Fast Torpedo Boat.—At a trial of Yarrow's new torpedo boat *Havock*, made near Gravesend early in December, the marvelous average speed of 30 miles an hour was obtained on a run of 100 miles.

The First Balloon Ascension in the United States.—The Herkimer, N. Y., *Democrat* is authority for the statement that the first balloon ascension in the United States was made by Messrs. Rittenhouse and Hopkins, of Philadelphia, some time in the year 1783, about 110 years ago.

A 100-lb. Rail on the Consolidated Road.—It is reported from New Haven that the work of relaying the tracks of the New York, New Haven & Hartford Road with 100-lb. steel rails has been completed between that city and Springfield.

An Omission.—The photographs of the United States cruiser *New York*, which were illustrated by half-tone engravings in our last issue, were taken by William H. Rau, of 1,324 Chestnut Street, Philadelphia, Pa. Owing to an oversight credit for the same was neglected at the time of publication.

Aluminum for Gas-holders.—Experiments have been made by MM. Goutes and Sibillot with the view of adopting aluminum as the material for the gas-holders of dirigible balloons, instead of silk or other stuffs, and the results of their experiments have been satisfactory.

Aluminium in Place of Tin.—In an article in the *Revue Scientifique*, M. L. de Djeri claims that aluminium will soon replace tin for many purposes. For equal volumes the price of the two metals is not very different, and the alloys of aluminium with copper, etc., are superior to those of tin.

Ships for the Manchester Canal.—The ships which will hereafter be built for use on the Manchester Canal are to have telescopic masts. The lower masts are of hollow steel, and the topmasts will be of wood and lowered into the former when the ship passes bridges.

New Process of Rain-Making.—A new process of rain-making was recently brought before the Academie des Sciences, Paris, by M. Baudoin. His theory is that electricity maintains the water in the clouds in a state of small drops, and if the electricity be discharged the water will come down.

Irrigation of the Mojave Desert.—The great project of irrigating the Mojave Desert by means of a mammoth dam to be built at Victor Narrows, on the line of the Southern California Railroad, appears to be an assured fact. Documents for the formation of a company have been completed and signed.

Italian Petroleum.—Attention has recently been called to the finding of sources of petroleum in Italy at Emilia, in the province of Chieti. The light given by it is of a clear opal color; 50 to 60 per cent. of the burning oil and 40 per cent. of benzine are obtained from it.

Pocket Telephone.—The policemen at Newcastle, Eng., are said to have been equipped with pocket telephones with a foot or two of wire attached. By means of these instruments they can communicate with the fire brigade through the fire signal boxes without breaking the glass doors of the same.

Aluminum Bullets.—Some experiments have recently been made for the purpose of developing an aluminum bullet, to be used in place of lead in rifle cartridges. It is calculated that a soldier can carry about 200 rounds. In testing the penetrating properties, it is said that they have been found to be superior to lead.

Benzine Wagon.—A four-wheeled wagon whose motive power is supplied by a benzine engine has been satisfactorily tested in Germany. It is intended to carry passengers through city streets or country roads, and can be run at the rate of half a cent a mile. The wagon and engine can be made for $500. The speed is as high as 15 miles an hour.

A New Gun.—M. Turpin, who is well known as a discoverer of the explosive melinite, has invented a new gun which is said to be very effective. Four charges can be fired from it in 15 minutes. These charges contain 25,000 projectiles, which are scattered over an area of 236,808 sq. ft. at a distance of 11,483 ft.

Longest Railway Tangent in the World.—The longest reach of railway without a curve is claimed by travelers to be that of the new Argentine Pacific Railway, from Buenos Ayres to the foot of the Andes. For 211 miles it is without a curve, and has no cutting or embankment deeper than 2 or 3 ft.

A Castle in the Air.—A Belgian engineer, Tobyanski, has evolved a project for an aerial castle for the Antwerp Exhibition. It is to be, judging from the illustrations published, an immense composite balloon consisting of six parts, which are to be held captive at a height of 1,600 ft. It is to be reached by elevators, and to have a café, observatories, etc.

India's Telegraph Service.—The report has been published that a great advance has been made in duplex telegraphy by an invention of one of the members of the Indian telegraph staff. It is said that duplex messages were recently transmitted without repeaters for a distance of 2,100 miles from Calcutta to Madras. The wire used was of copper.

Photographing Projectiles in Transit.—Professor Fritch, of Berlin, has succeeded in photographing projectiles in transit. He exhibited at a recent lecture photographs showing the air waves caused by the missiles, which formed a legible record of the velocity with which they traveled. The apparatus is said to be the invention of a boy named Vernon, of Edinburgh, Scotland.

A New Insulating Material.—The great electrical manufacturing concern of Berlin has introduced a new insulating material which is intended to replace rubber and vulcanized

fiber. It can, it is claimed, be turned, filed, and drilled more easily than hard rubber; fine screw-threads can be cut on it, and it can be polished. It does not attack metals, and can be used in place of marble and slate for switchboards. It resists a temperature of 450° F., and is unattacked by hydrochloric or dilute sulphuric acid.

First Test of the Air-pump.—The first public test of the air-pump was made in 1654 by its inventor, Otto von Guericke, in the presence of Emperor Ferdinand of Germany. Guericke applied the carefully ground edges of two metallic hemispheres, 2 ft. in diameter, to each other. After exhausting the air by his apparatus he attached 15 horses to each hemisphere. In vain did they attempt to separate them because of the enormous pressure of the atmosphere. The experiment was a great success.

Hungarian Railway Tickets.—The railway marks invented by the Hungarian Minister Lukais will shortly be adopted on all Hungarian railways. For the future no traveler on Hungarian railways will be troubled to stand waiting at the ticket office for his ticket. He will be in a position to make out his ticket for himself. On a blank card he will write the name of the station from which he takes his departure, and that of the station he means to go to, and he will stick on to the remaining empty space on the card as many "railway marks" as his journey will cost. The blank cards will be obtainable at all tobacco shops.—*London Daily News.*

Hand-hole Cover for Boilers.—We illustrate a man- and hand-hole cover that has been designed by Mr. A. B. Willits, of the United States Navy, for marine boilers. The plate is flanged inward, the edge faced and a steel plate cover used inside, pulled up to the face by a bridge and bolt in the ordinary way. It is simpler and better than the old flat hole stiffened by a ring riveted on.—*The Engineer.*

HAND-HOLE COVER.

Disincrustation of Boilers with Liquid Carbonic Acid.—The *Revue de Chimie Industrielle* says that at a recent meeting of the Scientific Association of Saxony one of the members described the use of liquid carbonic acid as a boiler disincrustant. The boiler having been filled with cold water, carbonic acid was introduced from a receptacle near at hand. When the water was saturated with the gas, the acid dissolved the carbonate of lime, which was the principal element contained in the scale, and precipitated the gypsum which was combined with it, leaving the sheets of the boiler perfectly clean.

Experiments with Shingles.—An interesting experiment with shingles was tried a short time ago, says a writer in an English journal. A green 6-in. cedar shingle, fresh from the saw, was measured and weighed, care being taken to get both exact. It was found that it weighed 7 oz. It was then dried and again weighed and measured. It had shrunk nearly ¼ in., while the weight had decreased from 7 oz. to 3 oz. It was then submerged in water 24 hours, and the size had not changed a particle, while the weight had increased 1 oz., demonstrating the superiority of cedar shingles over others, as when once dry they will neither shrink with excessive heat nor pry one another off the roof in wet weather.

Hardness of Copper and Zinc.—An interesting fact concerning the relative hardness of copper and zinc has been brought to light by means of M. Paul Jannetaz's new sclerometer. Most authors regard zinc as harder than copper. If, however, the metals are examined in a sufficiently pure state, it appears that copper is the harder of the two. This removes an exception to the rule that the harder the body the less its atomic volume.

Tunnel and Bridge to Copenhagen.—Owing to the accumulations of ice which cuts off Copenhagen from the mainland during part of the winter, it is now proposed to build a tunnel between the island of Seeland and Funen and a bridge between Funen and the mainland. The construction will be easy owing to the soft nature of the bottom, and the island of Spragal will be used for ventilation and other purposes. When the work is completed it is estimated to cost about £1,800,000. Copenhagen will be two hours nearer the continent.

Comparison of Artificial Lights.—It is stated that a careful examination under the spectroscope of various lights shows that the arc lamp and the improved incandescent gas-lights are the artificial sources of light that approach sunlight most nearly in nature; but all artificial light has a warmer or more golden light than daylight. Ordinary gas flames and ordinary incandescent lamps emit the red and yellow rays, and are consequently less satisfactory. It is believed that a light closely approaching daylight in character could be obtained by the use of colored reflectors with arc lamps.

A Colossal Microscope.—According to the *Annales Techniques*, a gigantic microscope is being constructed in Munich. It has a magnifying power of 11,000 diameters, but this can be increased to 16,000 by means of an electric light, the image in this case being thrown on a screen. In order that the heat of the lamp may occasion no expansion of the metallic parts of the armature and consequently displace the focus of the lenses, a bronze cylinder containing liquid carbonic acid is so arranged that a little liquid escapes when the temperature reaches a certain point, and by its evaporation reduces the armature to a normal temperature.

Preservation of Wood.—M. Verrier has made an application of the following method of preserving wood. The wood which is to be injected is cut in the months of August and October, and immediately stripped of all the lateral branches, merely keeping a bouquet of leaves at the end of each limb. The wood is carefully cut or sawed so that all the pores of the wood which are exposed are immediately placed in vats filled three-quarters full of water, into which from 175 to 230 lbs. of pulverized sulphate of copper is added per 100 galls. The bouquet of leaves, left at the upper end of each limb, is sufficient to cause an ascension of the liquid by virtue of the capillary attraction, and the ascensional energy of the leaves.—*Moniteur Industriel.*

Cement for Steam-pipes.—A cement of specially valuable properties for steam-pipes, in filling up small leaks, such as a blow-hole in a casting, without the necessity of removing the injured piece, has been compounded. The cement in question is composed of 5 lbs. of Paris white, 5 lbs. yellow ochre, 10 lbs. litharge, 5 lbs. red lead, and 4 lbs. black oxide manganese, these various materials being mixed with great thoroughness, a small quantity of asbestos and boiled oil being afterward added. The composition, as thus prepared, will set hard in from two to five hours, and possesses the advantage of not being subject to expansion and contraction to such an extent as to cause leakage afterward, and its efficiency in places difficult of access is of special importance.—*American Gaslight Journal.*

Smokeless Powder.—The adoption of smokeless powder in the Italian Army is likely to cost Italy dear. According to the *France Militaire*, the smokeless powder used by the Italian artillery has irreparably damaged a very large number of guns. The powder has produced such an effect upon the bores of the guns, that some 500 have already been condemned, and orders have been issued to considerably reduce the amount of gun practice. Enormous expense will, in consequence, be necessary to restore the Italian field artillery to its former state of efficiency, no less a sum than £8,000,000 being mentioned as the amount required. If the report as to guns being rendered practically useless through smokeless powder being used be correct, it will probably have an important effect on the development of these powders, which have received such a stimulus of late years.

Ventilation of Sewers.—The municipal authorities of an English town have accepted the offer of a local lighting company to provide electromotors for ventilating the up-take columns of sewers. The motors are to be continuously supplied with current for three months for $25 each, tests being taken in the mean time on the amount of foul air extracted from this sewer. The introduction of electromotors for this purpose is by no means the first occasion on which mechanical power has been employed for removing dangerous gases. Large blowers and fans have been successfully used for carrying a supply of fresh air through the workings at mines and collieries. Formerly the ventilation was effected by hot-air currents, a furnace being kept up in the up-take for the purpose of heating the outgoing air, and thus creating a draft.

A Type of Condenser.—An unusual type of condenser for use with steam engines is described in an English technical journal. It is built like an ordinary steam radiator except that it is much larger, the vertical pipes being slightly over 4 in. outside diameter. The exhaust steam from the engine enters one end of the coil of pipe, is condensed in its passage and is then pumped out of the other end by the air pump. A shal-

low trough extends along the top of the radiator, and is kept filled with water by a circulating pump; this water trickles down through fine holes in the bottom of the trough over the surface of the pipe, and keeps it cooled so that the steam within is condensed. The apparatus is placed on the roof of a shop, and has been working successfully for two years. Its advantage lies in the very small amount of condensing water required, which is only one pound per pound of steam.

Non-shrinking Timber.—The *Indian Textile Journal* is responsible for the statement that a timber known as "Billian," which grows plentifully in Borneo, is unaffected by water as far as dimensions are concerned, either when absorbing it or losing it by evaporation. It weighs 60 lbs. per cubic foot and it has a breaking strain 1.52 times that of English oak, while its weight is only 5 per cent greater. Compared with Burmese teak it is 62 per cent. stronger transversely, and 11 per cent. heavier. Billian or Borneo iron-wood is a hard, durable wood of a dark brown color. When seasoned it turns a deep red, and with long exposure becomes black as ebony. It resists the teredo navalis (so destructive among timber in salt water), and the white ant, and is almost indestructible. Its breaking strain is the highest of any known wood, and it is extensively used as sleepers, beams, piles and for any construction requiring strength and durability.

Petroleum and Coal Tar.—Petroleum and coal tar are frequently recommended and used to render posts durable, but their value varies with conditions. Coal tar applied hot may be made to form an impervious casing, shutting out air and moisture, but, of course, not preventing it from entering above. Bottled up in this manner it may promote decay. With different conditions it may prove a useful application, says *Country Gentleman.* With shingles it acts differently, being wholly exposed to the rain and air. Apply the petroleum by dipping the shingles in it in a tub of the oil, and allow a few hours for it to soak thoroughly into the pores of the wood, and then lay them in the usual way. It may be applied less perfectly to the shingles after they are laid, using a coarse brush for the purpose, and it should be renewed once in seven or eight years. It affects the rain-water only for a few weeks. In applying it to the roof crowd the points of the brush into the crevices between the shingles.

Utilization of Coal Dust in London, England.—The London *Times* gives an account of a process by which anthracite coal bricks are now being manufactured by the London Coal Brick Syndicate. The bricks are made of grains of anthracite dust, which are forced to cohere by means of a special cementing compound and by great pressure. The coal dust is mixed with the binding material in the proportion of 95 per cent. of the former to 4 per cent. of the latter. The compound is fed into a mixer, where it meets a jet of steam, a stiff paste being formed, which is delivered successively into a series of moulds under a pressure of 25 cwt. As the mould plate revolves the charge in each mould is brought between two rams, which exert a pressure of 2 tons per square inch on each side of the charge, forming a very dense and homogeneous coal brick. The brick, still in the mould, passes on to the delivery ram, by it is pushed out on to a table, and is removed for the market. These coal bricks are said to make an excellent fuel, and to possess a very high efficiency for steam-raising purposes. The *Times* thinks that with such a fuel at the disposal of the public there is room to hope for a reduction in the pollution of the atmosphere of towns.

Counterweight for Electric Cars.—Quite an ingenious method has been resorted to for assisting electric cars up a steep grade in Seattle. Two counterweights, aggregating 6 tons, run on a track in a conduit 3 ft. wide and 15 in. below the street surface, and at the bottom these weights abut against an air cushion made of two 8-in. wrought-iron pipes of 8 ft. length, inclosing 7-in. pistons of about the same length. At the other end of a steel cable attached to the counterweights is a small dummy running in a conduit 4 in. wide by 8 in. deep, placed above the larger conduit; this dummy has a bar hinged to it and projecting 8 in. above the ground, to which the draw-bar of the car is coupled. In operation, the loaded car descending the grade draws up the counterweight, which very nearly equals the weight of the empty car, the electric power and brakes being operated as on the level. In ascending, the counterweight comes down and pulls up the car, with the assistance of the electric motor to handle the load; when the car is uncoupled at the foot of the grade, an automatic catch holds the dummy in position for the next ascending car. Another simple but essential mechanism in carrying out this arrangement is the employment of a safety catch with the weights in case of breakage of the rope, and the coupling is automatic.

Basic Slag as Manure.—The slag resulting from the Bessemer basic process has been proved to possess valuable qualities as a manure, owing to the large percentage of phosphorus which it contains. As a tetra-basic phosphate of lime, in which form the element is present, it can be readily assimilated by plants, provided the slag is ground sufficiently fine. At the North-Eastern Steel Works a large milling plant has been erected, in which the whole of the slag, amounting to 25 per cent. of the total weight of steel produced, is ground by edge-runners or other means until about 83 per cent. will pass through a sieve of 120 wires per linear inch. It has been found by experiment that the efficiency of the manure is not increased by grinding it finer than this. Any small fragments of steel which may have become mixed with the slag are removed by magnets. The manure contains from 17 to 20 per cent. of phosphoric acid, 50 per cent. of lime, and 14 per cent. of iron oxides, together with smaller quantities of other ingredients. Exhaustive experiments have been made with the manure in this and other countries. It has been found most effective when mixed with other nitrogenous manures in the proportion of 4 to 1, and when 5 cwt. of the mixture is used per acre. It is then about equal to superphosphate in beneficial effect. At the price of 27*s.* per ton it commands a ready sale.

Gold Mining from a River-bed.—Gold is sprinkled throughout the Snake River country through Idaho, and there are numerous bars along the river that would prove profitable could water be commanded for sluicing or hydraulic work. To overcome this lack of water, as well as to insure sufficient dumping grounds, a big floating gold-saving barge has been constructed and is now at work on the Idaho bank of the Snake River about 10 miles above Payette. It is a stern-wheel flatboat propelled by steam. Substantially constructed, 65 ft. long and 22 ft. wide, it is equipped with a 35-H.P. engine and boiler. With a slight alteration it could be transformed into a steam dredge and used to scoop sand and gravel from the bottom of the stream. That has never been attempted. As in the past, operations are now confined to working bars out of the bed or channel of the river. The method pursued is to anchor alongside one of these gravel deposits and by the use of scrapers bring the material to be handled within the reach of the gold-washing machinery with which the craft is rigged. The gravel is scooped up by buckets attached to an endless chain. There are 48 of these receptacles on a belt 60 ft. in length, and each has a capacity of about 20 lbs. of dirt, which is delivered into a hopper. This is also an agitator, and the process employed may be described as a steam rocker, with the exception that it has an end motion instead of one sidewise. The gold is caught on copper plates with quicksilver. The tailings are carried off in sluice boxes by the force of a stream of water of 150 mineral inches, supplied by a China pump, run by the engine that drives all the other machinery. The gravel is worked so thoroughly that no gold escapes in the river. An average of 100 tons of gravel are daily handled, and for this work three men are employed—an engineer, one to work the scraper, and another one who shovels the dirt into a pile so that the buckets can scoop up a full load.

An Improvement in Furnace Boilers.—At the fall meeting of the Alabama Industrial and Scientific Society held in Birmingham, November 24, Mr. Murray, Superintendent of the Linn Iron Works, described an improvement which he had been able to make in furnace boilers, whereby the use of a double-decked boiler with cylindrical mud-drum suspended beneath and a modification of the Spearman-Kennedy gas burner had resulted in notable economy.

Mr. Murray was obliged to dismantle a battery of boilers at the Alice furnaces consisting of two 46-in. in diameter return-flue boilers 34 ft. long. As these boilers did not give enough steam and the new boilers had to be put in the same space as occupied by the old ones, the problem had to be solved to secure greatest heating surface in a limited space. The new boilers were built larger in diameter and plain cylindrical heaters were added under each boiler. This new battery consists of two 54-in. return-flue boilers 34 ft. long, each having two 10-in. flues. Under and connected with each boiler is a plain cylindrical heater 36-in. in diameter, 31 ft. 2 in. long. These heaters start 8 ft. from the front, giving room for the grate and the bridge-wall. The heaters pass through the back wall 2¼ ft. and a 20-in. mud-drum is suspended under the same on the outside of the brickwork. The same setting, hangings, and about the same brickwork were used as in the old battery. The new double-deck boilers give 1,660 sq. ft. of heating surface as against 1,040 sq. ft. in the old style, a gain of 61 per cent. The supplementary heaters afford 59 per cent. real gain. The increase of cost over the old system is only about 12 per cent.

Still better results were attained by introducing a separate jet of gas under the heaters in addition to the one under the boilers. For this purpose Mr. Murray designed a new duplex gas burner. The upper burner is the ordinary Spearman-Kennedy burner, the lower burner is connected with the base of the upper one through a 9 × 9-in. cast-iron pipe leading to a nozzle 24 in. × 3 in. Air for combustion is admitted on either side of the battery through the hot walls and envelops the gas-jet at its orifice from all sides. The results with this burner were very flattering, and the same is now used by several of the furnace plants in that district.

Accles Machine Gun.—The Driggs Ordnance Company, of Washington, have brought out a new machine gun invented by J. G. Accles. In a general way this gun resembles the Gatling gun, but has a number of important features. By a simple clutch at the side the firing mechanism can be thrown in or out of gear instantaneously, and, secondly, the gunner can easily throw a continuous stream of bullets, or fire shots singly—at the rate of about 400 shots per minute—the crank being turned at a steady rate all the time. The gun may be mounted on field-carriages, parapets, embrasures, and on all types of naval mountings. On board ships the guns are arranged so as to be actuated both by hand and by electricity. In using electricity the main current from the ship's dynamo is led to a smaller motor connected with the shaft which works the gun. Great rapidity of fire is obtained with this latter arrangement, 1,000 shots per minute having been fired accurately in recent experiments.

The gun fires only one shot at a time, and a cartridge cannot be discharged without the trigger being pulled. Turning the crank cannot, therefore, by any possibility, discharge cartridges unless the trigger is also pulled. The force of discharge is absorbed by the weight of the gun, so that there is no recoil or disarrangement of the aim caused by firing. While the habitual position of the crank is on the trunnion, a preferable location in the 10-barreled gun for accurate firing, it can be placed at the rear of the gun, making it possible to discharge all of the shots at each turn of the crank, or 30 shots a second, which is at the rate of 1,800 shots per minute. For the purpose of extreme rapid firing an arrangement is perfected by which the trigger can be locked in a position of permanent "pull," and rapidly turning the crank a constant stream of cartridges can be discharged. Placing the crank on the trunnion is thought by ordnance experts to be of great advantage, it being possible by having it in that position for one man to aim and fire the gun, as it is only necessary for the man to sit close to the breech of the gun to enable him to manipulate the crank attached to the right-hand trunnion. By this arrangement one man could load, aim, and fire the gun at the rate of about 600 shots a minute. It is thought that in action batteries may often be reduced to one man, and the possibilities in this respect are therefore of much practical value.

Novel Method of Track Shifting.—In the course of the four-tracking and other improvements on the New York, New Haven & Hartford Railroad between Woodlawn and New Haven, it has been sought to reduce the grades and to improve the alignment by reducing the curvature to 2°. At two places on the line there has recently been accomplished the shifting of long sections of track to embankments on the new grade without interruption of the regular traffic and at a low cost. Near Milford, Conn., there was a change of track extending 8,000 ft., with an average raise of 6 ft. and a maximum of 9 ft. The filling for third and fourth tracks had been brought to the new grade. Under former plans the two existing tracks would have been raised by a succession of such lifts as could have been properly tamped to permit of the safe passage of trains. The old tracks were, however, moved bodily on skids from the old to the new grade, making the new third and fourth tracks, and the old part of the railroad is then raised without interference from trains. The proposal to raise and slide the tracks on skids, with block and tackle, was so generally condemned by experienced trackmen that the roadmasters of the New York Division did not decide upon this step until an experimental strip had been removed by this means. The track was disconnected in five-rail lengths (150-ft. sections), and the skids, on which the sections were moved, consisted of rails spiked to 6 × 8-in. spruce timber, with dowels at each end, to which were attached the blocks and tackles. The work of shifting 8,900 ft. of track a distance ranging from 20 to 30 ft. and lifting it an average of 6 ft., was accomplished with 261 days' work, including the time of going to the work and returning, or, reckoning only the time actually spent in labor, a little more than 100 full days' work sufficed to place the track in position for surfacing. This stated to be about equivalent to that which under the usual methods would be necessary to draw the spikes, disconnect the rails, and to carry the ties and rails 25 ft., including the lift of 6 ft., after which it would be necessary to space and line the ties and to connect, gauge, and spike the rails. Four miles of track have been raised in this manner, including a stretch near Pelhamville, where the lift was 8 ft. and the lateral movement 35 ft. Experienced workmen brought the cost of this shifting down to 16 cents a lineal foot. The work was planned by C. C. Elwell, M., AM., Soc. C. E. Roadmaster of the division.

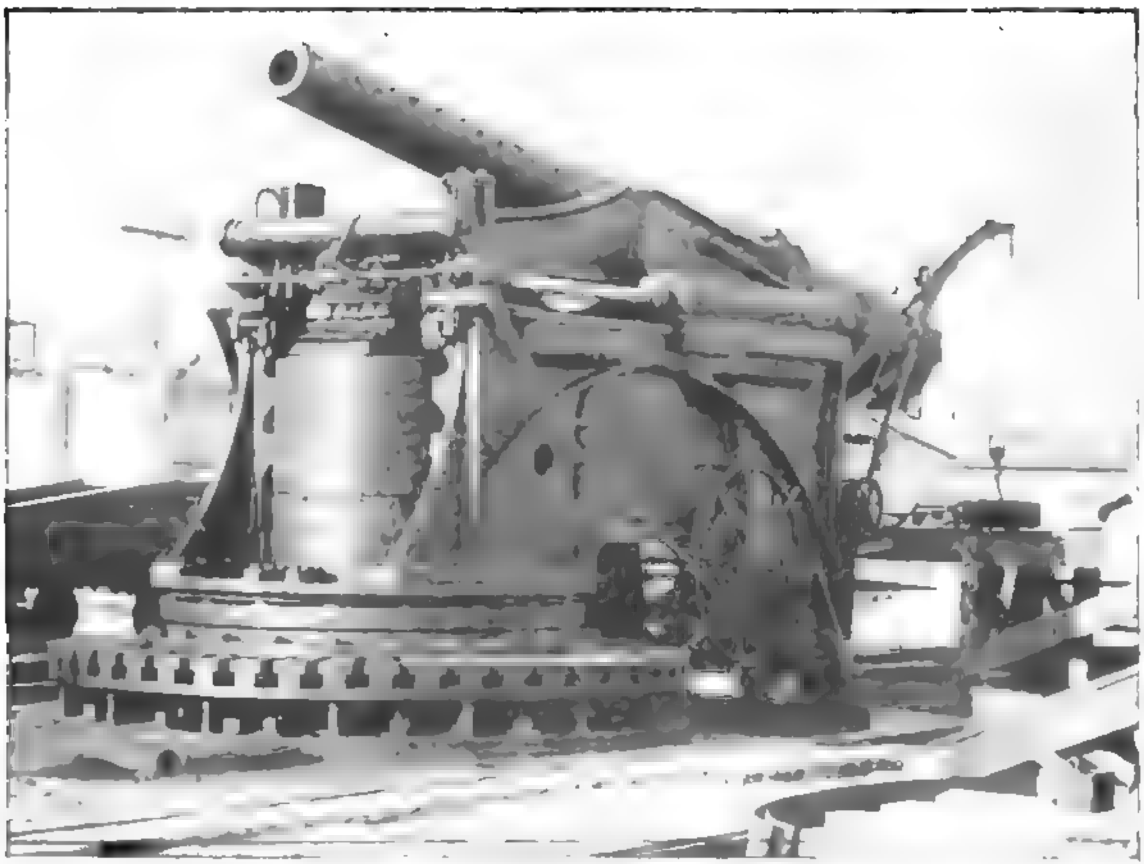
Travel on the Congo Road.—The Congo Railroad has arrived at the dignity of a time-table and schedules of passenger and freight traffic. What the road lacks in length it makes up in charges. It costs anybody who has a social position to maintain $10 to travel 25 miles. This is the first-class rate, and the drop from first to second class is precipitous and abysmal. The only accommodations for second-class passengers are such as they can find in the freight cars, but they can afford to stand up if need be, for they are required to disburse only $1 for transportation that costs the unfortunate few 10 times as much. Modern improvements in train management are a feature of the new African railroad. The fact that only one train a day starts from each terminus reduces to a minimum the danger of a rear-end collision; but as the Congo Railroad differs from our trunk lines in having only a single track, it is not expedient for trains to attempt to pass one another between stations. The four stopping-places along the line have therefore been connected by telephone, and conductors are under orders not to leave one station until assured by telephone that they will have a full monopoly of the track to the station ahead.

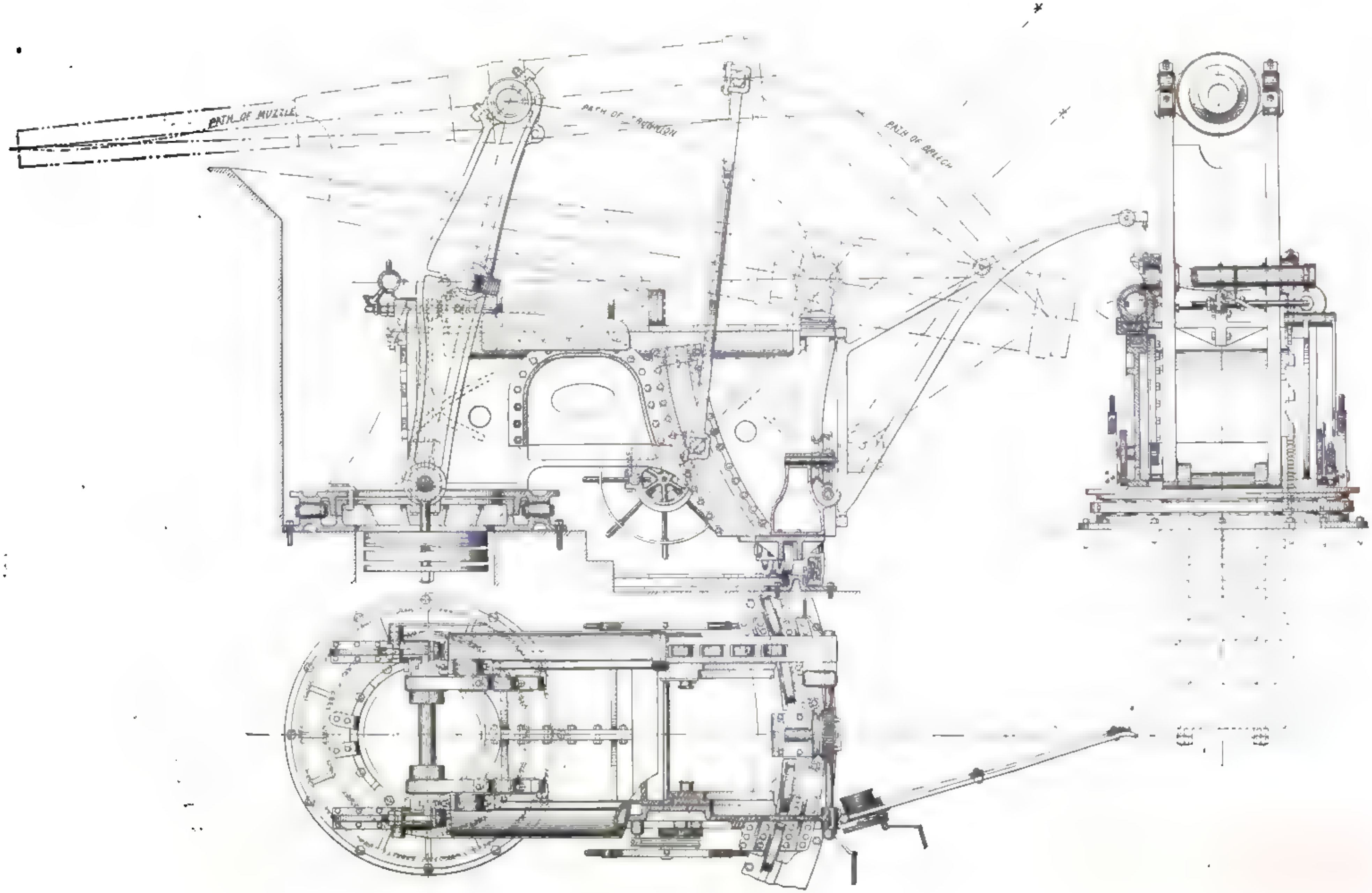
When the line is completed to Stanley Pool there will be a fine opportunity for tourists of the adventuresome sort to catch a glimpse of the lower Congo Valley and return to the sea breezes in a few days. It is to be expected that the progress of civilization will have a tendency to reduce the price of first-class tickets. The company, however, has a monopoly of railroad building for many years to come, and will be likely to charge all the traffic will bear, without any fear that competitive routes or ticket scalpers will demoralize rates. Of course, the needs of commerce and the pressure that the Congo Free State may exert will soon have a tendency to place all charges on a reasonable basis. The road is completed to Nkenge, 25 miles from its starting-point at Matadi. It is now fairly on the plateau behind the hills that overlook the foaming cataracts of the river. The road thus far has been hewn out of the toughest of rock, skirting first the Congo and then zigzagging up the Mposi River Valley, where a number of costly bridges were thrown over the troublesome stream. Nearly all the difficulties of the entire route have now been conquered and rapid progress may be made to Stanley Pool, where steamers from far and near will bring freight to the cars. Facts are stubborn things, and this railroad must astonish the small army of writers who affirmed a few years ago that white men could accomplish nothing in the trying climate of the Congo Valley.—*New York Sun.*

THE BUFFINGTON-CROZIER DISAPPEARING GUN CARRIAGE.

Immediately after the adoption of a policy on the part of the United States Government to increase the naval and coast armament of the country, the Ordnance officers came to the conclusion that for an efficient coast defense a disappearing gun carriage was an absolute necessity. This stimulated a number of inventors, and several types of disappearing gun carriages have been evolved which are more or less successful, some of which have been constructed under orders from the Government and have been tried under the supervision of the Ordnance Department.

Among the earliest attempts at the designing of such a carriage was that of Colonel Buffington, a modified form of whose carriage was tested at the Sandy Hook Proving Grounds on December 14, a memorandum of which was given in our January issue. The carriage is known as the Buffington-Crozier carriage. Captain William Crozier, whose name appears in connection with the carriage, was detailed by the Government a number of years ago to visit Europe and gather such information as would be placed at his disposal, in regard to the condition of the art in the several military countries, and report the same to this Government. He found no disappearing carriage which, in his judgment, would warrant the appropriation of large sums of money by this country for construction. He brought home one or two gun carriages, of Russian and French design, of the non-disappearing type, but on further investigation in this country he came to the conclusion that the principle underlying the construction of the Buffington carriage was one which could be developed into great efficiency, and he there-





THE BUFFINGTON-CROZIER DISAPPEARING GUN-CARRIAGE WITH 8-INCH GUN.

fore set about remodeling the carriage in such a way as to make it suitable for the heavy guns intended for the coast defense of the United States. The result of his labors is the carriage which was used in mounting the 8-in. gun at Sandy Hook, illustrations of which are given in this issue. We show three engravings of the carriage: two taken from photographs showing the gun in the firing and in the loading position respectively, and also a reproduction of a working drawing of the carriage, for which we are indebted to Captain Crozier.

The principle upon which the carriage works is that there is a heavy counterweight so adjusted that when it is released it will, by falling, raise the gun to the firing position. Upon firing, the recoil of the gun throws it back to the loading position, at the same time raising the weight so that it is all ready, upon a second release, to fall to the firing position. An examination of the photographs and the line engravings shows that the gun is supported at two points—the trunnions and breech—by levers which stand nearly upright when the gun is in the firing position. On either side of the gun there is a hydraulic cylinder which moves back and forth over a rigidly fastened piston. On this cylinder the levers, which carry the trunnions of the gun, are pivoted near their center point. At the other end of these levers from the trunnions the counterweight is attached. The counterweights are so held that in rising and falling their motion must be truly vertical; cross-heads attached to them, running in guides in the main castings of the carriage. The cylinders, on the other hand, in their motion to and fro run over the guides which are at right angles to the guides carrying the counterweights. It is, therefore, evident, from the well-known law which has been so often applied in the construction of ellipsographs, that when one end and the center of a lever are moving at right angles to one another, the further extremity of the lever, which in this case carries the trunnions of the gun, must move through an arc of an ellipse. Therefore, in the recoil of the gun, the trunnions move back from the firing to the loading position through the arc of a perfect ellipse. On the other hand, the levers which are used for supporting the breech of the gun are pivoted to blocks held in the body of the carriage, so that as the breech rises and falls it passes through the arc of a circle. When the combination of these two motions is carried forward to the muzzle of the gun it produces a very unique motion, and one which could not be excelled in the retiring of the muzzle to the loading position at a point back of the parapet. It is as though one should take the muzzle in the hand, push it back to the edge of the parapet, and then suddenly lower it behind it. The principle on which the gun is worked is therefore very simple, and one which will readily be comprehended from the description and the mechanism when coupled with an examination of the drawing.

The gun is aimed while it is in the loading position. It is aimed by means of a range finder whereby the angle of firing elevation is obtained, so that the gun is not exposed to the enemy's fire except for the time required to rise over the parapet and retire; the time of pulling the lanyard being almost inconceivably short. The method of aiming is exceedingly simple. The horizontal aiming is of course obtained by swinging the carriage to the proper point. The vertical elevation of the gun is very easily and quickly obtained, inasmuch as the gun is not moved while aiming. The levers which carry the breech are pivoted at their lower extremities in a block which is similar to the link block of a steam-engine using the Stephenson link for its valve motion. This block slides between a pair of guides which are curved to a radius equal to the length of the lever, and with their center at the center of the breech trunnion when the gun is in the loading position. The gun is, therefore, down on its bed and there is no strain whatever on these levers, and the lower end can be raised or lowered by a suitable mechanism of gears and worms without any very great effort, by one man. But the mechanism is self-locking, so that the moment the block reaches a point indicated on the guides as giving the suitable elevation, which has been obtained by means of a range finder, the gun is ready for being raised to the firing position, and the elevation is obtained by raising or lowering the height of this movable block at the lower end of the breech levers. The raising of the block decreases the elevation of the gun, and lowering the block increases the same. The extreme elevation possible with the carriage given is 15° of elevation and 5° of depression. When the gun is back of the parapet an angle of 7° depression from the edge of the parapet just clears the top of the gun. The counterweight of the gun, as we have said, moves in a vertical line. It falls freely. When it rises and the gun settles to the loading position, a rack on the face of the cross-heads is caught by pawls attached to the carriage, and when the gun is finally down the counterweight is held in its highest position. A crane attached to the rear of the carriage serves to raise the shell to the breech of the gun and facilitates loading, but as this need not be an integral part of the carriage, it can be arranged to suit the convenience and taste of the officers having charge of the work.

After the gun is loaded and the lower end of the breech-lever fixed so as to give it the proper elevation when it has reached the firing position, two men are stationed at the forward end of the carriage with levers projecting through loops and bearing against the pawls holding the counterweights. At the command "Heave," they throw their weights against these levers and disengage the pawls, afterward drawing the levers out of their sockets and laying them on the ground behind the parapet. The counterweight thus released immediately raises the gun to the firing position. In doing this the cylinders on the side of the carriage are drawn forward, so that the pistons are down to the bottoms of the same. These cylinders are, as we have said, intended for taking up a portion of the recoil. The resistance of the recoil is taken up one-third by lifting the counterweight and one-third by each of the two cylinders. These cylinders are arranged on the same plan as the ordinary type of hydraulic resistance cylinders, such as the Fletcher recoil used on the Driggs-Schroeder gun described in our January issue. It consists of an hydraulic cylinder filled with liquid having an internally projecting lug, which is approximately wedge-shaped on the inner side. The piston is cut out to allow for passage over this wedge. At the back end of the cylinder where the piston is located at the moment of firing, the opening between the wedge and the piston is the greatest, because the motion there is the fastest. This clearance decreases toward the other end of the cylinder, and calculations are made in this particular instance so that the actual resistance to the recoil of the gun runs constant throughout the whole recoil. The liquid completely filling the cylinder simply flows from one face of the piston over the other, and it is this resistance to the flow of the liquid which takes up the force of the recoil. We have now seen that at the moment the command "Heave" is given, the counterweights fall, raising the gun to the firing position and drawing the cylinders to the front side of the carriage.

When the gun is fired the reverse simply takes place. The gun is thrown back to the loading position, the cylinder forced to the back side of the carriage, and the counterweight raised until it is caught by the pawls and held.

The rapidity of the action of this carriage is shown by the tests which were held at Sandy Hook, and to which we have already referred, in which 10 shots were fired in 12 minutes and 3 seconds. The party who visited Sandy Hook to witness these tests being unaccustomed to the noise of the firing of large guns, was cautioned to take refuge behind something in order that the sounds might be broken and no injury done to their ears. The writer of this was, during the first three shots, behind a building and about 5 ft. from the corner. Immediately upon hearing the report he jumped forward, but before the corner could be reached, which, as we have said, was only 5 ft. distant, the gun was back in the loading position, showing the rapidity with which the work was accomplished. Afterward from another position the whole firing was witnessed, and the ease and grace with which the gun settled back was certainly very remarkable. While no actual time was taken as to that occupied by the recoil and the raising to the firing position, it was variously estimated that from three to five seconds from the time the word "Heave" was given until the gun was back in the loading position, the remainder of the time was occupied in loading. Thus it will be seen that, making the most liberal allowance of time given by any one present, the actual time in which the gun was exposed to the fire of the enemy for each shot probably did not exceed two and one-half seconds, and in the opinion of the writer was somewhat less than this. In firing there is no apparent jar or shock thrown upon any portion of the carriage. Everything works smoothly and easily, and it is difficult to realize that such tremendous energies are at work. The shots which were fired at the time of the trial in December weighed about 300 lbs., and were fired with charges of 125 lbs. of powder each. Aside from its interest to Ordnance officers as an important element in our system of coast defense, this carriage offers us one of the finest examples of close calculations in machine construction and the capabilities of American workmanship of which we have any knowledge.

The body of the carriage is constructed entirely of steel castings, some of which were at the time of their casting the heaviest that had up to then been made in this country, and which were made by the Midvale Steel Company, of Philadelphia, Pa. The working parts are of forged steel. The machine work was done, under the personal supervision of Captain Crozier, at the Southwark Foundry & Machine Works at Philadelphia, Pa.

AMERICAN AND ENGLISH LOCOMOTIVES.

(Continued from page 13.)

SPECIFICATION OF ENGLISH EXPRESS PASSENGER LOCOMOTIVE.

LONDON & SOUTHWESTERN RAILWAY.

TENDER FOR FOUR-WHEELS COUPLED BOGIE PASSENGER ENGINES AND TENDERS.

DRIVING AND TRAILING-WHEEL CENTERS.

THE wheel centers to be of good sound cast steel, of approved make, free from honeycomb and other defects. One wheel center out of 40 is to be tested to destruction under the following conditions:

The wheel center is to be raised in a running position and allowed to fall upon a solid foundation from the following heights: 10 ft., 15 ft., 20 ft., 25 ft., 30 ft.

Should any wheel center break at the two lower heights—viz., 10 ft. or 15 ft., and show defects on hard material, the Railway Company's Locomotive Superintendent or his Inspector shall have the power to reject the whole. The wheels to be inspected on the premises of the maker.

Tensile test pieces are to be taken from the wheel center to give a breaking strain of not less than 28 tons per square inch, with an elongation of not less than 20 per cent. in 2 in.

Each wheel center is also to be tested by being allowed to fall in a running position a distance of 4 ft. 6 in. on to a wooden block without showing any signs of defect.

All the wheel centers must be bored and turned, and have keyways cut strictly to template, so that they shall be exactly alike, and each wheel must be forced on the axle before the tire is shrunk on by a hydraulic pressure of not less than 80 tons. The rims must be correctly turned to gauge to receive the tires, and the whole wheel trimmed up so that the surfaces and lines are all fair and true. The wheel centers are to be turned to a diameter of 6 ft. 7 in., the rims are to be 4¾ in. broad, 2¾ in. thick at center, to have 22 spokes 2½ in. thick at the boss, and 4 in. deep, and at the rims 1¾ in. thick × 3½ in. deep. The bosses are to be bored out parallel to a diameter of 9½ in., and are to be 1 ft. 5 in. diameter. The cranks for the coupling-rods are to be cast solid with the bosses, 13-in. centers, and bored out parallel to a diameter of 5½ in. to fit the coupling-rod crank-pins. The crank-pin holes are to be bored in a suitable quartering machine. The balance weights to be cast solid, and to be different for the driving and trailing wheels. Care to be taken that each wheel is cast with its proper balance weight. Generally the wheel centers must be as shown on the drawing.

BOGIE-WHEEL CENTERS.

The bogie-wheel centers are to be of good sound cast steel of approved make; quality, manufacture and tests same as specified for driving and trailing-wheel centers. Each wheel center to be turned to a diameter of 3 ft. 3¾ in., the rims are to be 4⅝ in. broad, 2½ in. thick at center, to have 10 spokes 1¾ in. thick at the boss and 4 in. deep, and at the rims 1⅝ in. thick and 3½ in. deep. The bosses are to be bored out parallel to a diameter of 7 in., and are to be 1 ft. in diameter. The wheel centers must be bored and turned strictly to template, so that they shall be exactly alike. Each wheel center must be forced on the axle by a hydraulic pressure of not less than 70 tons. The wheel centers are to be fixed to the axles without keys.

TIRES.

The tires are to be of the best cast steel, manufactured by Vickers & Co., and are to be tested at the works of the maker in the following way:

Each tire is to be guaranteed to stand without fracture the repeated falling of a 1-ton monkey from a clear height, first blow 10 ft.; second, 15 ft.; third, 20 ft.; fourth, 25 ft.; fifth, 30 ft., and so on. Any tire which cracks or breaks before it has deflected one-sixth of its external diameter is to be rejected.

Test pieces are to be machined cold out of the tire without reheating the steel or treating in any way beyond cold machining for tensile test. The minimum tensile strength to be 44 tons per square inch, and to have an extension of not less than 15 per cent. in 2 in. A suitable and sufficiently large piece is to be sent to nine Elms for testing in a similar manner.

The contractor shall require the maker to provide at his own expense one additional tire for each 50 ordered, to be selected from the bulk by this Company's Locomotive Superintendent or his Inspector, and to be tested in his presence by the maker in the manner before described.

In the event of one tire cracking or breaking, or failing to stand the test, the company to have the power to reject the whole.

The number of the charge is to be stamped on each tire, and in the event of there being more than one charge in every 50 tires, a tire shall be selected from each charge and tested.

The maker's name and date of manufacture is to be stamped on each tire.

All the tires are to be 3 in. thick, of the form shown on drawing, and to be secured to the wheels with a lip and steel set screws 1¼ in. in diameter, 11 threads per inch. Each tire to be bored to gauge before being shrunk on the wheel center. Each tire to be accurately turned, so that the diameters and thickness shall be exactly similar.

AXLES.

All the axles must be of the very best cast steel, manufactured by Vickers & Co., and must be stamped with the maker's name and date of manufacture. Test pieces are to be made, giving a tensile strength of not less than 28 tons and not more than 32 tons per square inch, with an elongation of not less than 25 per cent, in 2 in.; a piece of a suitable length, 1¼ in. square, is to be bent double when cold without showing any signs of failure. The bogie axles to have centers of bearings 3 ft. 7 in., 5¾ in. diameter, 10 in. long. The driving and trailing-axles to have centers of bearings 3 ft. 9½ in., 8 in. diameter, 9 in. long. All axles are to be as shown on drawings.

DRIVING AND TRAILING AXLE-BOXES.

The driving and trailing axle-boxes to be as shown on drawing, of the best gun-metal, and to have bearing surfaces of Dewrance's anti-friction metal: keeps to be of cast iron. The axle-boxes to have lubricating pads as shown. There is to be only one groove in the crown of the axle-boxes, with the lubricating holes leading into it. The axle-box bearings to be $\frac{1}{16}$ in. shorter than the axle journal, to give clearance. The axle-boxes must have $\frac{1}{32}$ in. side play on each of the guides. Each axle-box must be made to gauges and must be duplicates of each other.

BOGIE AXLE-BOX.

The bogie axle-box to be of the best gun metal; keeps to be of cast iron, to have bearing surfaces and provision for lubrication, as shown on drawing. The axle-box bearings to be $\frac{1}{16}$ in. shorter than the axle journal to give clearance.

DRIVING AND TRAILING SPRINGS.

The springs are to be made of the very best quality of spring steel, manufactured from Swedish bar iron. Five per cent. of the bars to be tested at the works of the makers by the Railway Company's Locomotive Superintendent or his Inspector in the following manner: A piece to be cut from each bar 2 ft. 6 in. long, heated and bent round to a radius equal to 80 times the thickness of the bar, then hardened and tempered. The camber to be taken after it has been pushed straight once in the testing machine, after which the bar must be pushed straight six times without showing any further permanent set. The tensile strength of the bars to be not less than 45 tons per square inch, with an elongation of not less than 15 per cent. in 2 in. Manufacture and brand to be approved by the Railway Company's Locomotive Superintendent. The plates are to be truly fitted, tempered and stamped with the maker's name and date of manufacture. The plates to be prevented from shifting side or end ways by nibs stamped upon them. Care must be taken that the nibs formed on the plates fit the slots properly. The buckles are to be sound forgings and are to fit the springs accurately, and are to be well secured to them, the buckles to be prevented from shifting on the springs by short wrought-iron pins, driven while hot through holes in the top and bottom of the buckle, and into a hole in the top plate and a recess in the bottom plate, as shown on drawing. The springs are to consist of 12 plates ½ in. thick and 5 in. broad, to a span of 4 ft., and to have adjustable hangers at the end and solid hangers in the center. Each spring must be thoroughly tested before being put in its place, by being weighted with 11 tons, and on the removal of this weight the spring must resume its original form.

BOGIE SPRINGS.

The material, workmanship, method of construction and testing of the bogie springs must be the same as for the driving and trailing springs. The bogie springs are to consist of 14 plates ½ in. thick, 5 in. broad, to a span of 3 ft. 11¾ in.

SPRING GEAR.

A compensating beam to be attached to the driving and trailing springs, of wrought iron, forged as shown on the drawing, and fitted with a phosphor-bronze bush, pressed into its place by hydraulic power. It is to be carried by a forged cross-shaft, which is to be carried by two forged brackets, as shown. The ends of the springs which do not engage with the compensating beam must be provided with suitable forged hangers, as shown. The whole of the spring gear to be forged in a sound manner, free from all defects whatsoever. The spring and compensating beam brackets to be attached to the frame by ⅞ in. turned cold rivets of best Yorkshire iron, having a tensile breaking strength of not less than 22 tons per square inch, with an extension of not less than 30 per cent. in 2 in.

CYLINDERS.

The cylinders are to be 19 in. in diameter when finished, with a stroke of 26 in. The steam ports are to be 16 in. long and 1⅜ in. wide. The exhaust port is to be 16 in. long and 3 in. wide. The bars are to be 1⅛ in. wide. The cylinders are to be made of best close-grained, hard, strong cast iron ; they must be as hard as they can be made, to allow of their being properly fitted and finished, and must be perfectly free from honeycomb or any other defect of material or workmanship : they must be truly bored out, the front end being bell-mouthed. All the joints, covers and surfaces are to be planed or turned, and scraped to a true surface, so that a perfect joint can be obtained. All studs are to be tightly screwed. The cylinders are to be made with loose covers at both ends, provision being made on the back cover for carrying the slide bar. They are to be set in a horizontal line, placed at a distance apart of 6 ft. 2¼ in. from center to center, with steam-chest on side as shown on drawing. The holes in the frames and flanges of the cylinders are to be carefully rimered. When the cylinders are correctly set to their places they are to be firmly secured to the frames by turned bolts 1¼ in. diameter, driven home a tight fit. The cylinders are to be covered with lagging and clothing plates 14 Standard W. G. thick. The front and back cylinder covers are to be protected by clothing plates secured as shown. The cylinders before being fixed in position to be tested in the presence of the Railway Company's Locomotive Superintendent or his Inspector, by hydraulic pressure to 200 lbs. per square inch. All joints must be perfectly tight under this pressure ; the front and back cylinder covers and cylinders generally to be exactly to the drawing.

PISTON AND PISTON-RODS.

The pistons are to be made of cast steel, free from honeycomb or any other defects, to the form and dimensions shown on drawing, and are to be fitted accurately to the cone of the rods, and secured thereon by gun-metal nuts formed with collars, and taper steel pins through the nut. The piston-head is to be an easy fit in the cylinder ; the packing rings are to be three in number, of cast iron ⅝ in. wide, ½ in. thick, and turned all over. The rings are to be turned larger than the diameter of the cylinders, then to be cut and sprung in to fit the bore in the cylinders, and are to be prevented from turning round in the piston by dowel pins fixed in the position shown. When finished, the whole must be an easy and accurate fit, so that the finished rod and piston can be moved readily backward and forward in the cylinder. The piston-rods are arranged to work through both front and hind cylinder covers, and to be 3⅝ in. in diameter at back end and 2½ in. at front end, and are to be forged from the very best cast steel of approved make, with a breaking strength of 30 tons per square inch ; they are to be truly fitted to the heads, and are to be tapered where they enter the cross-head, and to which they are to be secured by cottars of mild Swedish steel. Full particulars of the various dimensions and tapers are to be obtained by reference to the full-size drawings.

METALLIC PACKING.

Both piston-rods to be fitted with the United States Metallic Packing Company's packing, which is to be obtained from that company. The hind cylinder cover is to be arranged, as shown on the detail drawing, to suit this packing, and the front cylinder cover to have a stuffing-box, which is also fully shown on the drawing.

SLIDE-VALVE.

The slide-valve is to be of the best Stone's bronze, to be made exactly as shown on the drawing, and with recesses in its working face.

VALVE-SPINDLES.

The valve-spindles and buckles are to be of best Yorkshire iron, and of the dimensions shown on drawing. The spindles are to be guided by gun-metal glands and bushes through the steam-chest ; the valve-spindle is to be tapered where it enters the valve-rod, and is to be secured by a cottar of mild Swedish steel.

SLIDE-BARS.

The slide-bars (one to each cylinder) are to be of the very best Yorkshire iron thoroughly case hardened, 6 in. × 3 in., of a manufacture and brand to be approved by the Railway Company's Locomotive Superintendent : they are to be attached with 1¼-in. bolts to the back cylinder covers, which must be accurately fitted to receive them, and at the back ends they are to be attached with bolts 1⅛ in in diameter to the motion-plate ; a brass liner ¼ in. thick is to be placed at each end between the bar and carriers. Each bar is to have 15 lubricating recesses placed zigzag, 2 in. in diameter, on the top, with a ⅝-in. hole in the recess leading to the bottom of the bar. Each bar to have a perfectly smooth true polished face all over the bearing surfaces.

CROSS-HEADS.

The slide-block rubbing pieces are to be of cast iron of the same metal as the cylinders, and are to be well provided with means of lubrication. The cross-heads are to be of the very best cast steel, free from honeycomb or any other defects.

The gudgeon-pins are to be of best Yorkshire iron case hardened, and are to be prevented from turning round in the cross-head by means of a key fitted in the outer jaw. The rubbing pieces are to be securely fixed to the cross head with ¾ in. diameter turned bolts well fitted into the holes. Great care must be taken that the sleeve works freely on the bar.

VALVE MOTION.

The valve motion is to be of the curved link type, and the expansion links are to be hung from the center. The eccentric pulleys are to be in two parts, the smaller being of best Yorkshire iron, the larger of cylinder metal, and are to be fastened on the axle by means of keys and set screws as shown. The eccentric straps are to be of good tough cast iron, free from honeycomb or any other defect. The throw of eccentrics to be 6 in. The eccentric oil-cups are to be fitted with a button and spring. The eccentric rods are to be of best Yorkshire iron secured to the straps as shown. All the wrought-iron work is to be of best Yorkshire iron ; the working parts are to be well and properly case hardened and re-cleaned up, and must be of the very best finish, and free from all marks and defects. All pins are to be of best Yorkshire iron, case hardened, 2 in. in diameter, and made to standard gauges. The motion is to be reversed by a screw gear fixed on trailing splasher on right-hand side of engine. The valve rods are to work through cast-iron guides bolted to the motion-plate.

The guides are to be bored out to fit the rods and to be made of cylinder metal, and to be provided with a lubricating box as shown. The guides are to be heated to a high temperature and then dipped in oil.

REVERSING-SHAFT.

The reversing-shaft to be forged from best Yorkshire iron. The levers are to be forged solid with the shaft, which is to be placed above the motion and carried by a cast-iron bracket with loose cap bolted to the frames with 1-in. bolts turned to gauge and made a driving fit ; these brackets are to be made of cylinder metal, and bored out to 3¼ in. diameter to take the reversing-shaft. The working parts of the shaft are to be properly case hardened. The reversing-arm is to be on the outside of the bearing. The shaft is to be made as shown on drawing, and to be a sound forging in every respect.

CONNECTING-RODS.

The connecting-rods are to be of best Yorkshire iron, forged solid in one length, 6 ft. 8 in. from center to center, and are to be fitted with adjustable brasses of gun-metal at big end, and the small ends are to be fitted with gun-metal bushes accurately fitted and pressed into their places by hydraulic power. All bolts to be of best Yorkshire iron, and all cottars of mild steel ; the cottars are to be accurately fitted, and provided with set screws and cross-cottars. The brasses at the big ends are to be lined with white metal. Oil-cups are to be forged solid with the big end straps ; at the small ends a recess is to be made for lubrication.

COUPLING-RODS.

The coupling-rods are to be forged from best Yorkshire iron and machined out, to form the H section ; the ends are to be

accurately fitted with gun-metal bushes, pressed into their places by hydraulic power, so as to insure a perfectly tight fit, and to be secured as shown, the bushes to have five grooves ⅛ in. wide and 1/16 in. deep, fitted with white metal. All oil-cups for connecting-rods, coupling-rods and eccentric straps to be provided with a button and spring, and are to be duplicates. The rods must be made in every particular as shown clearly on the detailed drawing.

CRANK-PINS.

The crank-pins are to be of best Yorkshire iron properly case-hardened on the wearing surface. The hole in the wheel is to be parallel as shown; the pins are to be accurately fitted and pressed into the wheels before the tire is shrunk on by hydraulic power of not less than 80 tons, and riveted over on the inside. Cottared washers are to be placed on the ends as shown on detail drawing.

STEAM PIPES.

The steam pipes in the smoke-box to be of copper, No. 6 Standard W. G., and 4 in. inside diameter, to have gun-metal flanges at both ends properly brazed to the pipes and accurately faced so as to secure steam-tight joints. Each steam pipe is to be led to the cylinder and is to be secured to the same with studs and brass cover-ended nuts.

VORTEX BLAST-PIPE.

The blast-pipe to be Adams's Patent Vortex, of the form and dimensions shown in the drawing, with an annular exhaust. The blast-pipe is to be secured to the cylinder with studs and brass cover-ended nuts.

BRAKE.

The engines are to be fitted with a steam and an automatic vacuum brake. The brake material, which must be obtained for each engine from the Vacuum Brake Company, 39 Queen Victoria Street, E. C., will consist of one combination ejector, one steam cock for ejector, one automatic steam-brake valve on left-hand side of engine, one vacuum gauge, one drip receipient, one dummy, one of Clayton's hose and couplings for front of engine, one of Clayton's hose and couplings for connecting main air-pipe of engine to tender, one wrought-iron pipe from ejector to smoke-box passing through the boiler on right-hand side of engine, main air-pipe, with the necessary T pieces, elbows and clips, one end pipe with cast-iron bend for front of engine. The brake material, which will be supplied by the contractor, will be as follows: One steam brake cylinder with piston and rod complete; one copper pipe, 2 in. inside diameter, No. 10 Standard W. G., leading from the ejector to the trailing end of the engine; one copper pipe 1½ in. inside diameter, No. 10 Standard W. G., leading from the steam cock on the boiler to the top of the ejector; two copper pipes ⅝ in. inside diameter, No. 14 Standard W. G., one from the automatic steam-brake valve for supplying steam to the cylinders, the other leading to the ash pan; one copper pipe ½ in. bore, 16 Standard W. G., leading from the union on the main air-pipe below the ejector to the steam-brake valve; one copper pipe ¼-in. bore, 16 Standard W. G., leading from steam-brake valve to vacuum-gauge; one wrought-iron pipe 2 in. inside diameter, No. 7 Standard W. G., leading from the smoke-box tube-plate to the bottom of the chimney, to have a hole ⅜ in. in diameter at bottom of bend.

The driving and trailing-wheels are each to have one cast-iron brake-block applied to them. The brake gear is to be provided with adjustment, and made of the best hammered scrap iron, all the pins and working parts being case hardened. The pins through all points of suspension of levers are to be 2 in. in diameter, and to have brass bushes where shown; the brake gear must be as shown on drawing.

INJECTORS.

Two No. 8 gun-metal injectors, Dewrance's patent, with removable half cones, are to be fixed one on each side of engine as shown, to deliver into clack boxes placed at front end of boiler. The delivery pipes are to be of copper, 1½ in. inside diameter, No. 8 Standard W. G. thick. The steam pipe is to be of copper, 1½ in. inside diameter, No. 10 Standard W. G. thick. The overflow pipes are to be of copper, 1 in. inside diameter, No. 10 Standard W. G. thick. Care must be taken that the pipes are so set that the flanges of all joints come fairly to their places without any spring upon them. The pipes are to be solid drawn and perfectly uniform in length, and set so that any pipe will fit into its respective place on any engine equally well. The injectors are to be fitted with a feed-pipe arrangement as shown. The hose pipes are to be connected to the injectors by a brass casting.

BOLTS AND NUTS.

The bolts and nuts are to be made exactly to the lengths and sizes shown on drawing, and are to be Whitworth's standard. All are to be finished bright where not otherwise specified. All nuts are to be case hardened. All nuts inside smoke-box are to be of hard brass with blank ends.

CLOTHING.

The boiler and fire-box are to be lined with felt and well-seasoned pine in strips of not more than 2½ in. wide × ¾ in. thick, tongued, grooved and painted with asbestos fireproof paint on both sides, the whole to be neatly covered with clean and smooth steel sheets, No. 14 Standard W. G. thick, to be kept 1½ in. above the fire-box, and carried parallel the whole length of the boiler and fixed at top by angle-iron as shown, the steel sheets to be secured at the joints with hoop-iron bands 2½ in. wide, with tightening screws at the ends; the beading on front end of boiler to be of sheet brass to the shape shown on drawing, and finished to a perfectly clean and polished surface. The manhole casing is to be of charcoal iron, No. 14 Standard W. G. thick, and is to be fitted with a cast-iron shield for safety-valve columns. The dome casing is to be of charcoal iron, No. 14 Standard W. G. thickness, brazed up solid and painted.

CAB.

The sides and front are to be of Best Best Staffordshire iron 3/16 in. thick. The roof is to be of wood, tongued and grooved, and covered with oil cloth to this company's pattern; the roof is to be supported by angle irons and an iron strip as shown; a ledge is to be formed at each side, to prevent water falling on the men. The cab is to have two windows of best polished plate glass, ¼ in. thick, in brass frame, hinged on the top and provided with fastenings as shown. The front edges of the cab and top of hand rail plate are to be stiffened with angle-iron and beading polished. A hand-rail finished bright is to be fixed on each side of the engine outside the cab. A cord communication to the whistle is to be provided on the outside of the cab on right-hand side of engine as shown on drawing.

GENERAL MOUNTINGS.

Each engine is to be supplied with the following: One Ramsbottom's duplex safety valve with cast-iron columns and brass valves and seats, the springs to be set so that when the eye-bolt is screwed down to the shoulder the steam shall blow off with a pressure of 175 lbs. per square inch in the boiler. One of Bourdon's pressure gauges, 7 in. in diameter, to indicate up to 200 lbs. pressure, to this company's pattern. Two water-gauges complete with flanges, Dewrance's patent, with glass guard, and with pipes leading to the ash-pan. One large and one small whistle. Two steam cocks, Dewrance's, for the supply of the injectors, to be fixed with the whistles to one seating on top of fire-box. One blower-cock placed on side of smoke-box worked by a wheel and screw-valve from foot-plate on right-hand side of engine; and a copper pipe is also to be led from blower-cock through the smoke-box to the top of exhaust-pipe, and one from the blower through the tube-plate to the dome. Two clack boxes, one on each side of the boilers. Two drain cocks to each cylinder, to be worked from the foot-plate as shown; one lubricator fixed on each side of smoke-box, with pipe leading to steam-chest. One lubricator screwed into each front cover of cylinder. One oil-box and pipes led down to top of each piston-rod and valve spindle glands, and fixed as shown. One lubricating-box is to be placed over the leading and driving axle-boxes with pipes leading to the axle-boxes and guides. One watering-cock attached to the injector delivery pipe on left-hand side of engine. One regulator quadrant and stuffing-box complete finished bright. Four tapered plugs, one in each bottom corner of fire-box 1¼ in. in diameter, 12 threads per inch. Three filling tapered plugs on back of fire-box 1¼ in. diameter, 12 threads per inch. Four tapered wash-out plugs, two on each side of back of fire box above foot-plate, 1¼ in. in diameter, 12 threads per inch. Eight wash-out taper plugs in smoke-box, 1¼ in. in diameter, 12 threads per inch. One wash-out hole with covering plate on each side of fire-box at bottom. One wash-out hole with covering plate in front and back of fire-box. Two small tool boxes with padlocks and keys, one box to be hung on each side of engine inside the cab. One water-gauge lamp bracket to this company's pattern fixed on the tray over fire-door. Five lamp irons at front of engine to this company's pattern, four to be fixed on front of smoke-box, one on front of buffer plate. All plugs and mountings are to be of gun-metal, and must be of first-class finish. Pitch of threads for mountings is to be 12 threads per inch, unless otherwise shown on drawing.

The injector and whistle seatings and valves, blower cock,

clack-boxes, water-gauges, cylinder and steam-chest lubricators are to be to this company's pattern.

TOOLS.

Each engine is to be supplied with the following tools: One complete set of spanners, including two gland and two mud plug spanners; one punch for tapered pins; one large round drift for motion pins; one flat drift for cottars; one large monkey-wrench; one small monkey-wrench; one hand hammer; one quarter hammer; one pinch bar, two chisels; one pair of tongs; one bunting bar; one traversing screw-jack and ratchet, which must be exactly *to this company's pattern;* one oil can, 16 lbs.; one oil can, 8 lbs.; one oil can, 4 lbs.; one tallow can; one tallow feeder, two oil feeders to pattern; one pricker; one rake; one fork, one coal-pick; one shovel.

Three head lamps, two water-gauge lamps, and one hand-lamp are to be supplied to this company's pattern. A sample set of fire irons will be supplied by this company.

PAINTING.

Before any paint is applied, the iron-work must be cleaned and be free from scales and rust. The boiler is to receive one coat of boiled oil while warm, and two coats of Torbay red oxide paint, before being lagged. The inside of clothing to receive one coat of red oxide. The outside of clothing plates, plates, wheels, the sides and front of cab, and sides of splashers, to have one coat of lead color, two coats of filling-up, stopped with hard stopping, then rubbed down, followed by two coats of lead color faced with pumice stone between, after which two coats of light green to pattern. The picking-out and fine lining are to be to pattern panel, which will be supplied by the company. The outside of frames, guard-bars, tops of splashers, smoke-box, chimney, back of fire-box, ash-pan, foot-plate, brake work, and side springs are to have one coat of lead-color paint and two coats of japan black. The inside of frames and cross-stays to have one coat of Torbay red oxide and one coat of tan color to pattern. Front of buffer plates and buffer casing to be painted vermilion; inside of cab to have one coat of lead color, two coats of filling-up, and two coats of tan color to pattern. The axles are to have one coat of lead color, and one coat of Japan black. All the painting on the outside of the engine to have three coats of the best engine copal varnish of the very best quality, and flatted between the coats.

TESTING.

The boiler must be tested before being lagged with warm water to 262 lbs. per square inch, or to one and one-half times the working pressure; to be tested in steam to 175 lbs. per square inch, and to be thoroughly tight under each test. The boiler is to be tested in the presence of the Railway Company's Locomotive Superintendent or his Inspector.

QUALITY, ETC.

All the materials and workmanship are to be of the very best description, and all the various parts are to be applied in the best and most approved manner.

All the iron-work is to be stamped with this company's initials.

The contractor will be required to make complete general and detail drawings of the engines and tenders, and to supply this company with two complete sets of cloth tracings of them, free of charge. Great care must be taken that all parts of the engines are precisely of the dimensions shown, so that they may be duplicates of each other.

One of the engines and tenders is to be photographed at the contractor's expense, and twelve copies are to be supplied to the company. All the working parts of the machinery are to be well case hardened. The number of engine is to be figured in gilt numbers on front buffer plates, and by solid brass number plates on the hand-rail plate on each side of the engine. Samples of the gilt numbers and drawing of the brass number plates will be supplied by the company.

SPECIFICATION OF SIX-WHEELS TENDER.

DRAWING NO. 6,740.

Principal Dimensions.

	Ft.	In.
Diameter of wheels on tread	3	9¼
Center to center of journals	6	6
Length of journal	0	9
Diameter "	0	5¼
Diameter of axle in wheel	0	6¾
" " at center	0	6¼
Wheel-base	13	0
Length of frame	19	9¼
Total length of wheel-base from center of leading bogie wheels of engine to center of hind wheels of tender	44	8¼
Length over all, from front buffers of engine to hind buffers of tender	58	8¼
Height of center of buffers from rails	3	5
Capacity of tank	3,300 galls.	

TANK.

The tank to be of the form shown. The tank-plates are to be of the Best Best Staffordshire iron. Each side-plate of the tank is to be in one, ¼ in. thick. The bottom-plate of the tank to be ⅜ in. thick, jointed as shown, and to form the foot-plate of tender. The height of top of foot-plate from rail to be 4 ft. 1½ in. The end and front-plates to be ¼ in. thick. The top to be made of two plates 5/16 in. thick, jointed as shown. A stiffening plate ⅜ in. thick to be riveted to the top of the tank at the front end. The tank to be thoroughly stayed by plates, angle and tee-irons in the manner shown. The front-plate is to be cut out to form a doorway for coaling, and is to be fitted with a door hinged from the bottom, and secured at the top by suitable fastenings. Two wrought-iron tool-boxes are to be provided at the front of the tank, one on each side of the tender. Another tool-box is to be fixed across the tank on the top at the back. All tool-boxes to be fitted with false bottoms, perforated with small holes, and to be perfectly water-tight at the top; the tool-boxes are to be provided with padlocks and keys. The tank to be provided with a manhole or tank-filler and lid 1 ft. 6 in. in diameter, to which is to be attached a suitable sieve as shown. The angle-irons throughout to be 2½ in. × 2½ in. × ⅜ in. The tank to be riveted up with ⅝-in. rivets 1⅝ in. pitch, countersunk outside in the sides and end of the tank. The coping plates which are attached to the sides and end of the tank to be finished with a wrought-iron half-round molding piece as shown. Tank and well to be made entirely independent of the framing, and fixed as shown. A well to be provided 13 ft. 8¾ in. long, 3 ft. 11 in. broad, and 1 ft. 6 in. deep, of plates ¼ in. thick, stayed and riveted in the same way as the tank. One filling-cock for bucket is to be fixed on right-hand side in front of tank as shown. A wash-out plug is to be fitted to the bottom of the well.

One hand-rail is to be fixed on each side of the back of the tank, and is to be finished bright; four lamp irons to this company's pattern are to be fixed on the back of the tank, and one lamp iron on each side of the tank, as shown.

FRAME.

The frame-plates, cross-stays, stretcher-plates, hind buffer-plates to be of steel, same quality and manufacture in every respect as specified for the engine main frames.

Each frame is to be made of one plate, ¾ in. thick, and all holes are to be marked and drilled from one template. The axle-box guides are to be made of cast iron, planed, fitted, bolted to frame, and must be free from cross-winding and square with the frames in all directions. The horn-stays are each to consist of two 1¼-in. bolts with cast-iron distance pieces accurately fitted between the horns. All the cross-stays are to be accurately fitted to the frames and riveted to them by ⅞ in. diameter rivets. The frames are to be accurately tested by longitudinal, transverse and diagonal measurement, and must be perfectly parallel to each other. The front buffing and draw-beam is to be constructed as shown, and is to be provided with buffers, fitted with volute springs, to this company's pattern. The draw-bar is to be forged in one, the hole at one end being punched. Wrought-iron steps are to be provided, roughed and fixed where shown. The hind buffing and draw plate is to have a draw-hook and bar furnished with one of Spencer's No. 6 india-rubber cylinder to this company's pattern, two cast-iron buffers the same as specified for the engine, two side chains and screw coupling made of best chain cable iron, and to drawing. Two steel life guards are to be bolted to the frame behind the hind wheels.

AXLE-BOXES.

The axle-boxes are to be made of cast-iron fitted with a wrought-iron top and with the best gun-metal bearings lined with Dewrance's anti-friction metal, and to have cast-iron keeps provided with lubricating pads. The axle-box bearings to be 1/16 in. shorter than the axle-journal to give clearance; front and hind axle-boxes must have ⅛ in. side play, and the center axle-box ½ in. side play on each side of the guides, as shown on drawing.

SPRINGS.

Tender springs to be of same quality, workmanship and manufacture as specified for the engine springs. Each spring to consist of 16 plates, one plate ½ in. thick and 15 plates 7/16 in.

thick to a span of 4 ft., each spring to be provided with hangers at the ends, and buckles in the center, as shown. Each spring to be tested with a weight of 8 tons, and must resume its original form after testing.

WHEEL-CENTERS.

The wheel-centers to be of good sound cast steel of approved make, quality and manufacture, and tests same as specified for engine. Each wheel-center to be turned to a diameter of 3 ft. 3¾ in.; the rims are to be 4¼ in. broad, 2¾ in. thick at center, to have 10 spokes 2¼ in. thick at the boss and 4 in. deep; at the rims 1¾ in. thick and 3¼ in. deep. The bosses are to be bored out parallel to a diameter of 6¾ in., and are to be 11¾ in. diameter. All the centers must be bored and turned strictly to template, so that they shall be exactly alike, and each wheel-center must be forced on the axle by a hydraulic pressure of not less than 70 tons. The wheel centers are to be fixed to the axles without keys.

TIRES.

The tires to be 3 ft. 9½ in. diameter on tread, and in every other respect to be same as the engine tires, both as regards section, quality of material, and workmanship, and to be manufactured by Vickers & Co. The same tests to be applied as for the engine tires.

AXLES.

Each axle must be made of the very best cast steel, quality and tests as specified for the engine axles, and to be manufactured by Vickers & Co. Centers of journals to be 6 ft. 6 in.; diameter 5½ in. and length 9 in.; other dimensions as shown on drawing.

SAND-BOXES.

Two cast-iron dry sand-boxes with circular valves are to be fixed in front of the tender. Sand-pipes are also to be fixed as shown, the sand to be led within 3 in. of the rails by wrought-iron pipes 1¼ in. inside diameter. The general arrangement of sand-boxes and gear are shown on drawing.

FEED-PIPES AND COCKS.

Two feed-cocks to this company's pattern, to be fixed at the bottom of the well as shown, two copper pipes 2-in. bore, 8 Standard W. G., to connect the feed-cocks with the gun-metal stuffing-boxes, as shown. Strong hose pipes to be provided, clipped at the tender end to the stuffing-boxes, and at the engine end to the feed castings. The copper pipes to be fixed by suitable clips, the whole arrangement to be as shown.

STEAM-BRAKE.

A steam and hand-brake combined is to be fixed on tender as shown; the cylinder, 10 in. in diameter, is to be provided with means of lubrication; the brake-screw, which is to be left handed, is to work in a cast-iron column bolted to the foot-plate at the front end of the tender, and the front pulling-rod is to be provided with adjustment as shown; each wheel is to have one cast-iron brake block applied to it. The brake gear is to be made of the very best hammered scrap iron, all the pins and working parts being of wrought iron case hardened, all pins to be to drawing and to have brass bushes where shown. The steam is to be led from the engine to the cylinder with a connection as shown.

The brake material, which must be obtained from the Vacuum Brake Company, 32 Queen Victoria Street, E. C., for each tender, will consist of one main air pipe with the necessary T-pieces, elbows and clips, one of Clayton's hose and couplings for front of tender, one of Clayton's hose and couplings for back of tender, one end pipe with cast-iron bend, one dummy, one drip recipient. The brake cylinder, piston and rod complete are to be supplied by the contractor. The brake gear generally to be as shown on drawing.

PAINTING.

Before any paint is applied, the iron-work must be clean and free from scales or rust. The inside of the tank to have two good coats of thick red-lead paint, the outside being prepared and finished in a similar manner to the engine. The top and bottom of the tank, foot-plate and brake-work are to have one coat of lead color paint, and one coat of japan black.

The gilt numbers are to be put on the tender buffer-plate, and letters on sides and small numbers on ends of tenders, according to instructions and samples which will be supplied, and all the iron-work is to be stamped with this company's initials.

GENERAL CONDITIONS.

The engines and tenders must be made to the dimensions given in the foregoing specifications, and to drawings to be supplied by the Company's Locomotive Superintendent, except in cases where his consent to an alteration has been obtained in writing.

The quality of the materials to be of the make specified, and when no instructions are given, both materials and workmanship are to be of the best of their respective kinds, and all the working parts interchangeable.

Before ordering any material, the contractors must first submit to the Locomotive Superintendent, for his approval, the names of the firms from which the contractors propose to order the material; and obtain in writing his sanction to the same.

Complete detail drawings will be supplied on application to the Locomotive Superintendent which must be accurately worked to, and no advantage is to be taken of any omission of details in the specifications or drawings, as the contractors may obtain on application to the Locomotive Superintendent a full explanation of any part of the work not sufficiently shown or understood.

The engines and tenders must be finished and complete in every respect, and to the entire satisfaction of the Locomotive Superintendent, who shall be at liberty to inspect, either personally or by deputy, the work during its progress, and to reject any defective or unsuitable materials or workmanship.

The Locomotive Superintendent also to have the right of testing from time to time, as specified, or by additional tests, any portion of the material used in this contract. The tests may be made either at the works of the contractors, the company's own works at Nine Elms, or those of any other firm he may hereafter decide upon, and should the tests not appear sufficiently satisfactory to the Locomotive Superintendent, he may reject the whole or any portion of the material. The entire cost of all tests of materials, whether chemical or mechanical, that may be required by the Locomotive Superintendent, must be made at the expense of the contractors, including both the cost of the material and the preparation of the same for testing.

The engines and tenders are to be delivered by the contractors, free of charge, to the railway company at Nine Elms fit and ready for work; and prior to payment in the usual way at the end of the second month after delivery, each engine and tender will be required to run 1,000 miles consecutively without showing any defects in materials or workmanship, and the contractors will be held responsible for all defects that may appear, accidents excepted, until they have run that distance. In the event of the engines and tenders not being delivered at the time and in the numbers specified, the company reserve to themselves the right of delaying the payment, proportionate to the amount of delay in the delivery of the engines and tenders.

All royalties and patent rights to be paid by the contractors.

In case of any dispute arising, either during the progress of the contract or at its termination, the decision of the Company's Locomotive Superintendent is to be taken as final and binding in every respect

APPARATUS FOR RAPID LOADING OF COAL INTO SHIPS.

By G. Braet.

The swinging hydraulic hoist for coal, or the hydraulic kolentip built for the Rotterdam docks, by the Armstrongs, of England, and forming a portion of the plant of Feyenoord, is one of the latest applications of this system of loading coal. The accompanying engravings show, fig. 1, plan, and, fig. 2, a photographic reproduction of the plant and its method of operation. We also subjoin to the end of this article an extract from the regulations regarding the use of this swinging crane.

Another apparatus for loading coal is the Marillier hydraulic elevator of the Albert dock, at Hull, in England, built by the Hydraulic Engineering Company, of Chester, and it is shown by the engravings, fig. 3. This elevator is built on the continuous system—that is to say, the coal cars enter from one side by a side track, are raised to the requisite height, and are then unloaded, and afterward descend and go out on the side track on the other side of the elevator. The use of turn-tables, which are necessary in other systems, are therefore not required in this case, so that there is considerable saving in time and expense.

The apparatus consists of a wooden framework in which three platforms are located: two are movable and one fixed where the hydraulic machine and shute is located. The movable platforms on either side are used respectively for raising the loaded cars and lowering the empty ones. The stationary platform of the machine contains the hopper into which the

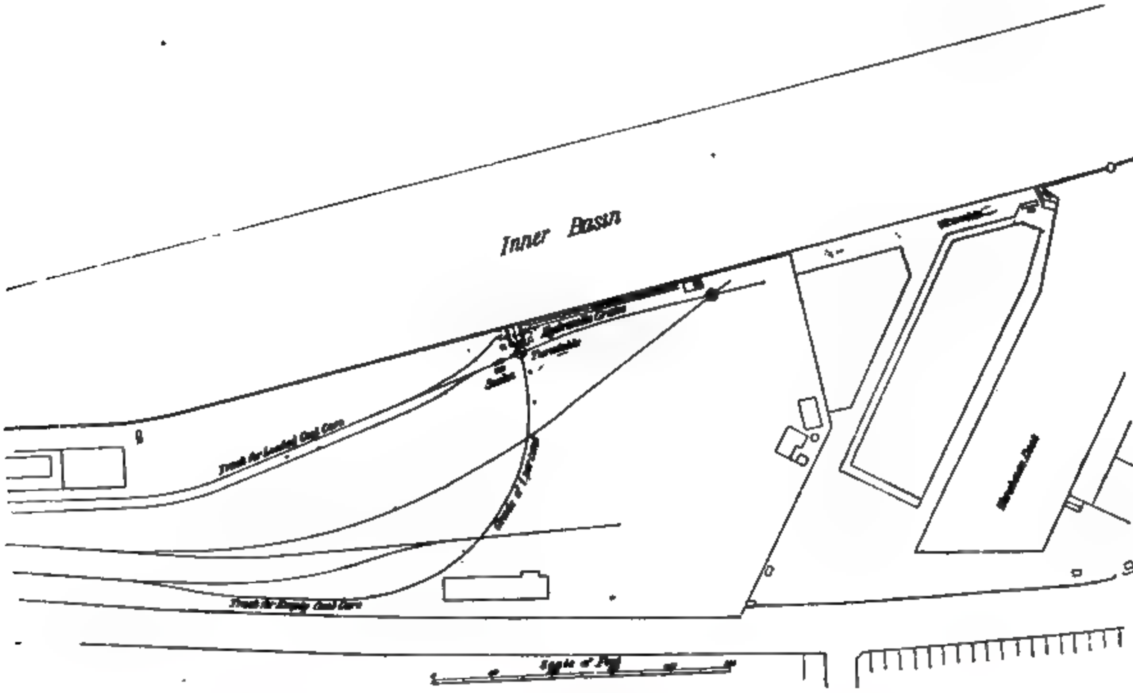


Fig. 1.

PLAN OF HYDRAULIC KOLENTIP AT ROTTERDAM, HOLLAND.

Fig. 3.

MARILLA HYDRAULIC ELEVATOR, ALBERT DOCK, HULL, ENGLAND.

coal is unloaded from the car. The method of operating the elevator is as follows: The full cars, having been hauled on to the first platform, are raised to a height of 28 ft. at least by a hydraulic direct-acting lift fixed in one of the pits under the platform. If the cars are hopper-bottom cars, they run out on to the center of the platform and are there unloaded, and then, after having been run upon the descending platform, drop down and are hauled out on to the track and coupled to the other empty cars which have preceded them. The rails of the three platforms are located on a slight incline so that the car is easily moved from one to the other. The engravings show three cars being handled at the same time. One full car is going up; a second is being emptied, and a third, which is already emptied, is coming down.

In the mean time the cars are being hauled up to the elevator by a capstan driven by a three-cylinder hydraulic motor built by Brotherhood. With hopper-bottom freight cars this elevator can handle about 300 tons an hour.

For some years past coal has been loaded into vessels at the James Watt Dock, at Grenock, by means of traveling cranes with a capacity of about 25 tons, which were built by Mr. Appleby. The boom of this apparatus has a swing of 21 ft. 2 in. beyond the end of the quay, and at this height it is about 78 ft. 9 in. above the level of the water. It can lift and turn in all directions, and is evidently built in such a way that it handles coal with great facility and so that either of the tracks on the quay can be used for the reception of loaded or empty cars. The turning portion of the crane is mounted on a movable framework traveling over two tracks with the standard gauge of 4 ft. 11 in.

The rails which carry the crane itself are placed at a distance of 5 ft. 11 in. on either side of the ordinary track, so that the gauge of the track of the crane is 28 ft. 2.6 in. The height of the opening is such that locomotives and the largest loaded cars can pass beneath, so that the crane can lift anything which can come on to the quay without opposing any obstacle to the movement of the rolling stock and without cramping the space which could otherwise be utilized. The motive power used is steam from the crane engine; and the capstans, which are also driven by steam, are fitted to the frame for the purpose of handling loaded or emptied cars. The following is the method of operation: As soon as the car is caught in the cradle which is suspended to the lifting chain, they attach the chain which controls the tumbler. The drums are then started and the car is raised to the desired height; the brake is applied to the drum of the traveling chain and the other chain is slackened off. The car is thus held by the back side and the contents are discharged; then the car is placed upon the track for empty cars. The operation of turning and raising takes place at the same time, and requires three minutes to raise a car perfectly, regardless of its capacity. The engraving, fig. 4, which is herewith given, shows the traveling Appleby Crane.

At present there are some arrangements used in France in the Department of the North of Calais, including the immense coal basin, which comprises, as we know, one-thirtieth of the concessions, and the annual production of which is given in their report as more than 1,000,000 tons. The transportation by canal being cheaper than by railroad, some companies, and these the most important, have made a connection between their docks and the canals; the Lens Company, as well as the Noeux-Bruay companies, have built loading wharves for their coal; and this latter, after having been loaded on cars at the mines, is hauled to a point near the docks and unloaded into boats by means of tumblers and cranes.

The mechanism used must satisfy the following conditions: To unload the coal without a shock being given to any part of the boat, and still keep it in the uniform merchantable condition; second, to reduce the work of leveling off as much as possible—that is to say, the redistribution of the coal down to a suitable deck level after the loading; third, to work rapidly.

The Mechanisms of the Société Charbonnière de Lens (*Figs.* 5 to 8).—The different points of this coal handling station are connected to the coal-loading station by a network of tracks having a total length of more than 12.4 miles, and which include more than one-half the tracks about the station. They run along the dock for a distance of 908 ft. There are 50 hoppers distributed along the railroad, over which the coal cars are stationed and the contents of which are dumped into the hoppers; a machine with a circular crane on a parallel track successively lifts each car. The whole of the system includes, first, a hopper used as an intermediate between the car and the vessel; second, a special machine equipped with a crane intended for raising the body of the cars. A word of explanation is necessary regarding each of these two installations. First the hopper: each hopper may be considered as composed of a fixed and movable portion. The fixed portion is composed of cast-iron plates fastened to the masonry wall of the wharf by means of pieces of wood built into the mason work. This fixed portion narrows down toward the edge of the wharf and has two inclinations. At the top it is 42°, and toward the bottom, where the inclination is the greatest, it is 50°. The movable portion includes a shute and a neck. The shute is formed of sheet metal, and is arranged so that it can be fixed at different inclinations, in order to regulate the height of the

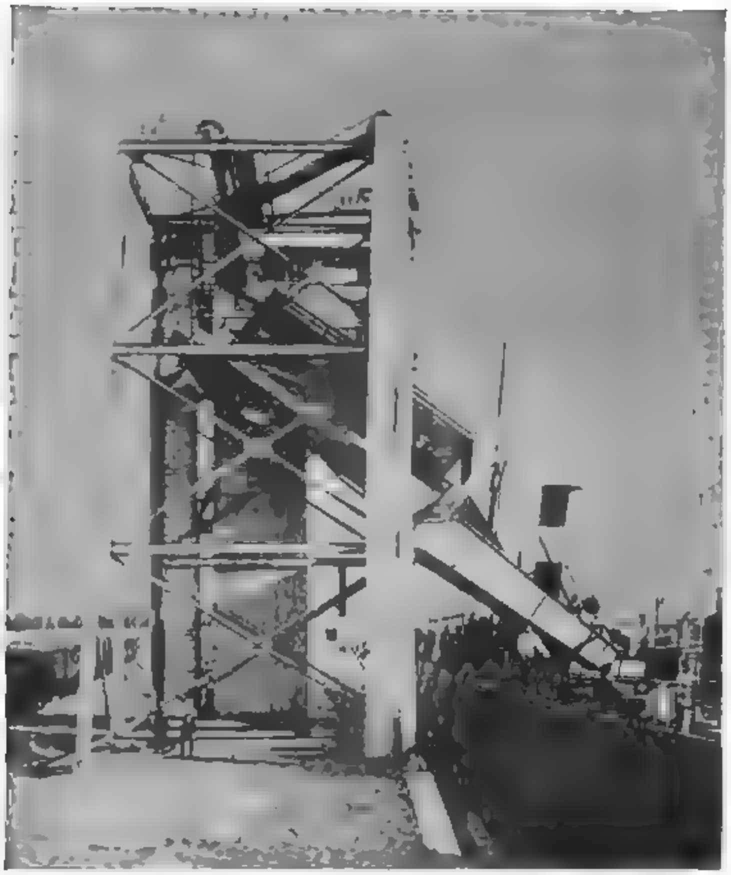


Fig. 2.

HYDRAULIC KOLENTIP AT ROTTERDAM, HOLLAND.

fall of the coal from the hopper into the boat, in order that the coal may not be broken or injure the boats. The neck is pivoted at the end of the shute and can be put in different positions, permitting the distribution of the coal along the whole length of the vessel. A sluice gate closes the opening of the fixed hopper when the boat is not ready to receive its load at once. Counterweights balance the weight of the movable shute, and thus make its manipulation easy.

Methods of Transportation.—The Société de Charbonnière de Lens uses single box cars, which have been found to be particularly satisfactory. The box of these cars is made of iron, and stands directly on the frames; the capacity of the box is limited transversely by pieces fastened to the car's sills, which abut directly against the longitudinal sills of the car. The sides of the car are movable; the center is formed of two panels opening vertically, and the ends can swing about a horizontal hinge fastened to the upper portion of the box. The opening of the doors at the level of the frame is provided for.

Motor Apparatus.—The motor apparatus, as we have already said, is a supplementary steam crane placed alongside of the machine to which it is attached. The boom of this crane is surmounted by a pulley over which a chain passes which has

a hook at one end intended to catch beneath the box of the car and raise it when steam is admitted into the cylinder of the crane. The manipulation of this mechanism is as follows: The machine, after having placed the loaded cars on the track alongside the hoppers, runs out on a parallel track and stops consecutively opposite each car. The hook of the crane is placed beneath the box. The side parts are set free from the sides of the hoppers, and then the crane is set at work and the box is inclined, and the side doors opened so that the coal is dumped into the fixed hopper. After having lowered the box into its place, the machine is advanced to a point opposite another car, and the same operation repeated. When the coal is to be dumped from the fixed hopper into the boat it is merely necessary to open the gate which is flush with the wall of the wharf, and the coal is allowed to run down into the movable shute and from thence into the neck; by working the crabs located on the top of the wall of the wharf, whence the neck is so handled as to distribute coal conveniently into the boat. The raising of the single box is accomplished without any difficulty whatever; the oblique direction which the chain of the crane takes, and the arrangement of the axis of rotation contribute to give sufficient stability to the whole of the car. With the Lens apparatus 800 tons of coal can be loaded per hour. Figs. 5 to 8 also show an arrangement which has been adopted by the Lens Company for turning coal cars into the tilting barrels which are to transport it. This method of unloading coal can be used at important points where the level of the track is located above that upon which the tilting cars are run.

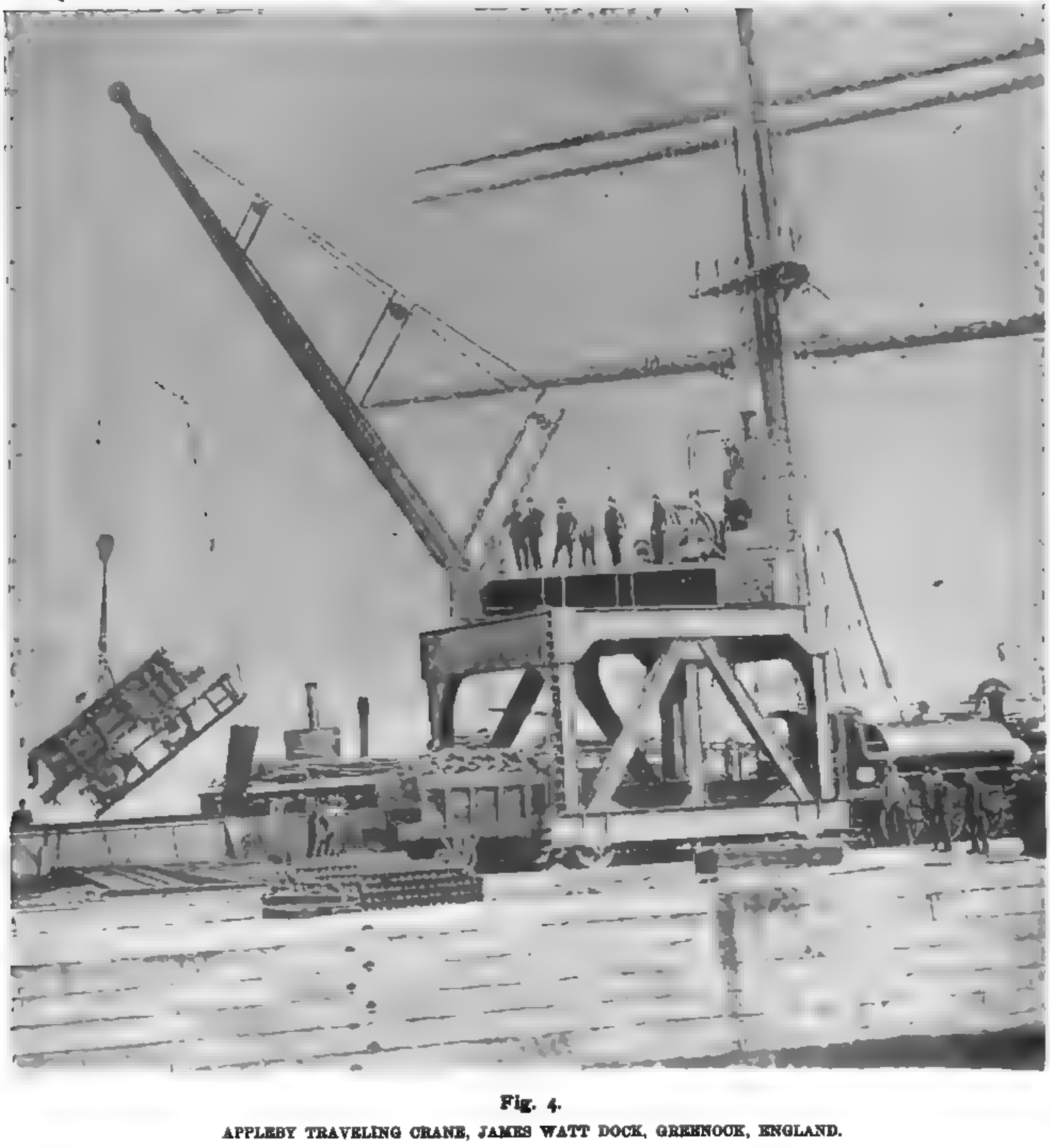


Fig. 4.

APPLEBY TRAVELING CRANE, JAMES WATT DOCK, GREENOCK, ENGLAND.

EXTRACTS OF THE REGULATIONS FOR THE USE OF THE COAL TIP AT ROTTERDAM.

The length of the cars, measured between ends of the buffers, must not be more than 28 ft. 10.5 in., and the outside projections on either side must not be more than 4 ft. 10.8 in. from the center of the track. The weight of the loaded cars must not be more than 39,690 lbs. The cars must be provided with an opening which is easily opened and runs their whole length. Cars which do not fulfil the above conditions cannot be run on the tip without special permission from the Superintendent.

The fee of $.05 per ton will be exacted for the use of the tip. This fee presupposes the delivery of the cars at a point indicated by the Superintendent or his subordinates and situated near the tip, the running of the cars on to the platform, the opening of the side doors, the tipping and replacing the emptied cars on a near by track. For emptying cars whose dimensions exceed those laid down in the above conditions, the Superintendent is empowered to increase the fee up to 50 per cent., according to circumstances. The charge for weighing a car on the scales of the track near by will be $.12 per ton of net weight with a minimum charge of $.73. The net weight is to be obtained by deducting as tare the weight marked on each car. A memorandum will be given on demand of the total weight thus handled. Detailed certificates of weight will be delivered to interested parties on the payment of a fee of $.02 per car with a minimum charge of $.24.

The commune assumes no responsibility for accuracy of weighing or certificates. The above fee includes the use of the crane belonging to the tip for evening off the ballast in a boat at the beginning of the loading, provided the ballast does not exceed 6 per cent. of the total quantity. The Superintendent is allowed at the request of interested parties to allow this maximum to be exceeded, but if this is done a supplementary charge of $.07 per ton will be charged for this work. If the crane is used in the handling of the coal it is at the risk of the interested parties. The minimum charge for the use of the tip is placed at $2.92. The fees shall be increased 30 per cent. for the use of the tip at night, and on Sundays and holidays the minimum charge will be exacted when the tip has been engaged but not used.

Fig. 5.

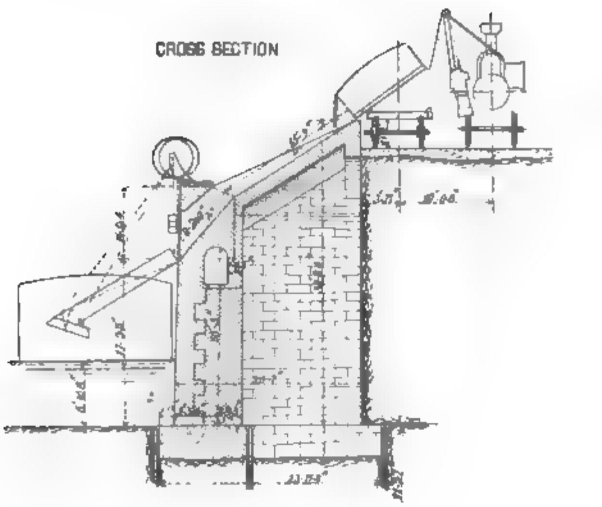
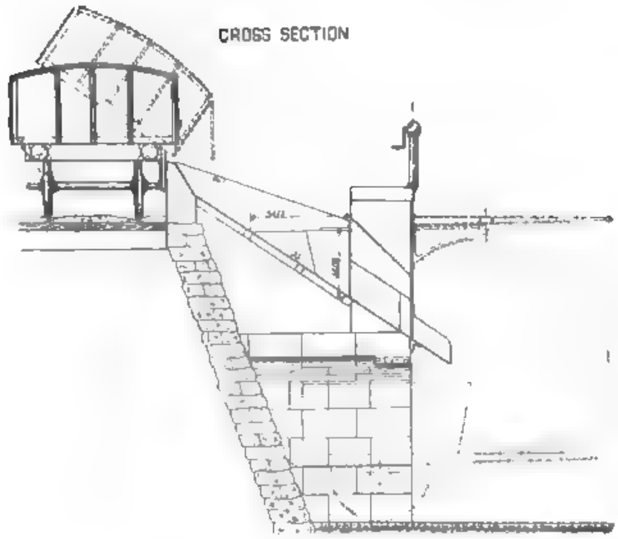


Fig. 7.



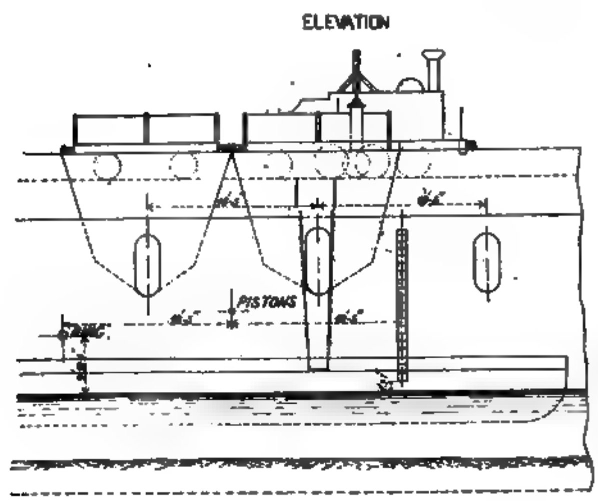


Fig. 6.

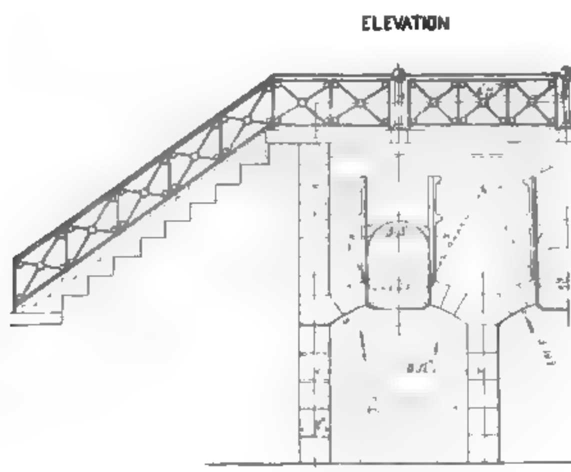


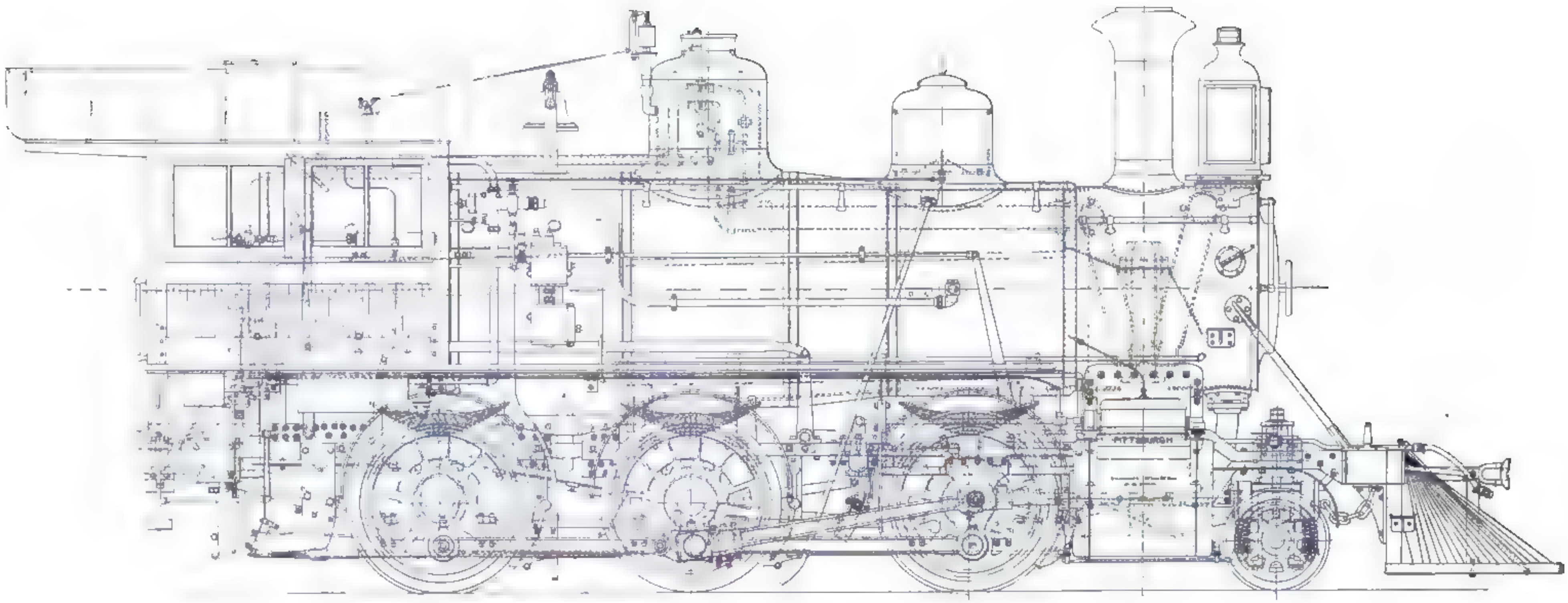
Fig. 8.

MECHANISMS OF THE SOCIÉTÉ CHARBONNIERE OF LENS.

COMPOUND MOGUL FREIGHT ENGINE BUILT BY THE PITTSBURGH LOCOMOTIVE WORKS.

Among the locomotive exhibits at the Chicago Exposition were five built by the Pittsburgh Locomotive Works, of Pittsburgh, Pa. One of them was a compound mogul, illustrations of which we give on the two following pages. The weight of the engine, which is 116,200 lbs. in working order, of which 100,500 lbs. is on the driving-wheels, is an exemplification of the tendency of modern construction toward the higher weights, in order to obtain the adhesion necessary for hauling the heavy trains which are demanded by the department of transportation.

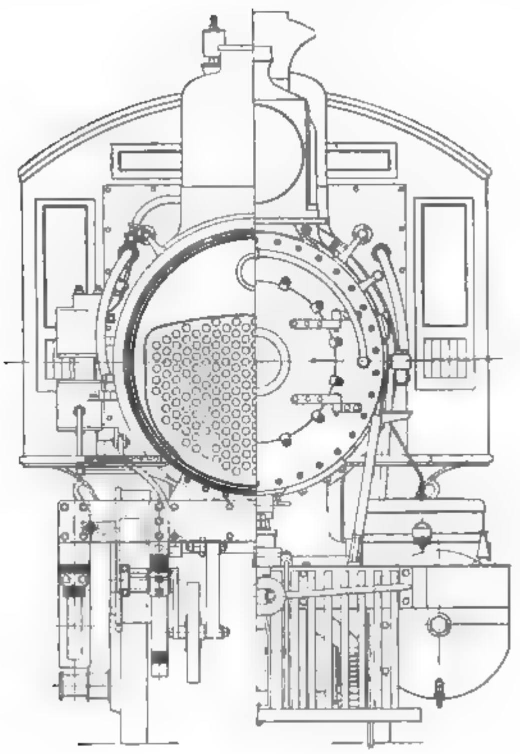
The engravings which we present give a front and rear elevation with a cross-section through the cylinders, and in a future issue we hope to be able to give a detailed illustration of the starting mechanism which is peculiar to these compounds. The diameter of the high-pressure cylinder is the same as that of the English and American locomotives which we have been illustrating in detail during the past year, and the stroke is the same as that of the English engine. In making a comparison between the details of the compound and that of the English engine, we find that the size of the high-pressure steam-ports is 1¼ in. × 20 in., while those of the two engines to which reference has been made are 18 in. × 1¼ in. for the American engine and 16 in. × 1⅜ in. for the English. But it must be remembered that we are here comparing a freight compound with two typical express engines, so that while the cylinder capacities are practically the same, the amount of



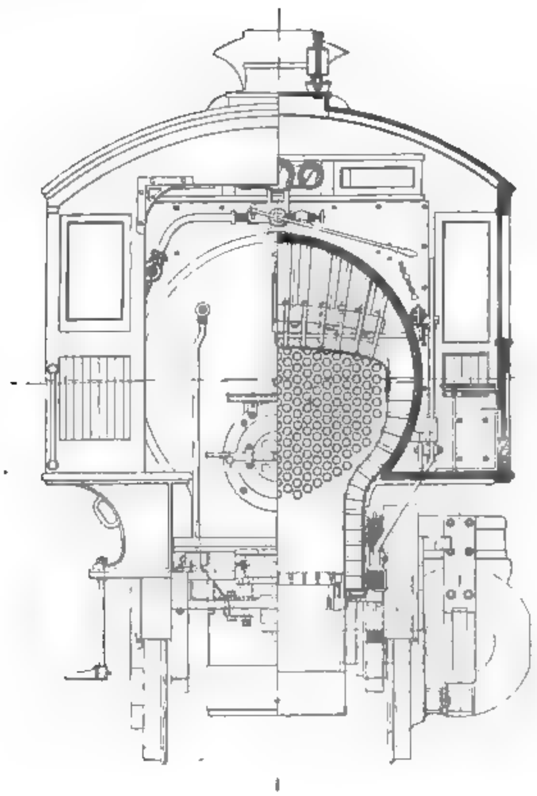
COMPOUND MOGUL FREIGHT ENGINE, BUILT BY THE PITTSBURGH LOCOMOTIVE WORKS.

port opening which is given to the three engines under working conditions is very much less for the express engines than for the freight, while the weight of the freight engine is almost exactly an arithmetical mean between the two express engines. In the construction of the boilers the riveting of the English engine is quadruple for both longitudinal and circumferential seams; for the American express engine it is sextuple-riveted for the horizontal seams and double-riveted for the circumferential, and this latter is the type of riveting which is also used on the Pittsburgh freight. From 3½ in. to 4 in. may be taken as standard thicknesses of the water legs, although the English has but 3 in. at the front and back, while the American express engine has 3 in. at the sides and back.

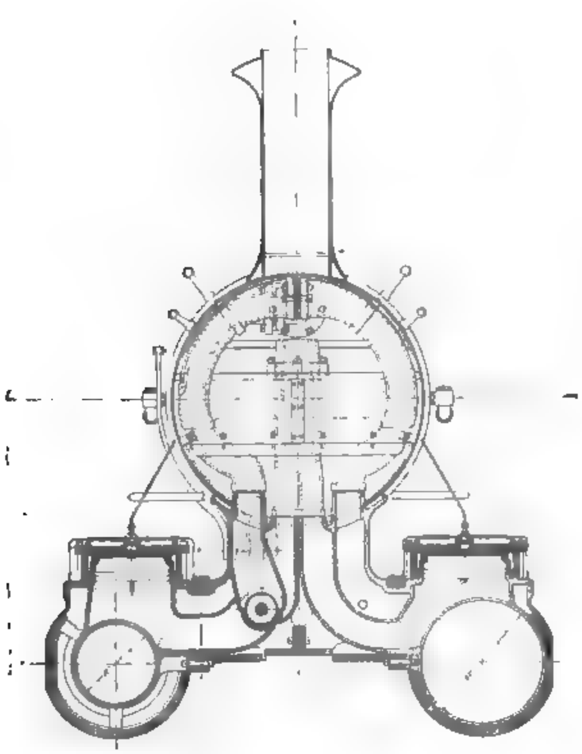
Regarding the details of the valve-motion, it is, of course, useless and unprofitable to make a comparison, because the services for which the engines have been designed are so entirely different. The following is a list of the dimensions of the various details of the engine:



FRONT ELEVATION AND SECTION OF SMOKE-BOX.



REAR ELEVATION AND SECTION THROUGH FIRE-BOX.



CROSS-SECTION THROUGH CYLINDERS.

WEIGHT AND GENERAL DIMENSIONS.

Gauge of road	4' 8½"
Actual total weight of locomotive in working order, including two men	116,200 lbs.
Total weight on driving-wheels	100,500 lbs.
" wheel-base	20' 10"
Distance between front and back driving wheels	18' 2"
" from center of main driving-wheels to center of cylinders	5½' 4"
Length of main connecting-rod from center to center of journals	7' 1$\frac{5}{16}$"
Transverse distance from the center of one cylinder to the center of the other	7' 4"

CYLINDERS, VALVES, ETC.

Diameter of L. P. cylinder and stroke of piston	29" × 26"
" of H. P. " " " " "	19" × 26"
Horizontal thickness of piston over piston-head and follower-plate	6"
Jerome metallic piston packing	
Diameter of L. P. piston-rod	3⅝
" " H P " "	3½
Size of L. P. steam port	1⅝" × 20"
" " H. P. " "	1¼" × 18"
" " L. P exhaust port	3" × 20"
" " H. P. " "	2½" × 18"
Greatest travel of L. P. slide valve	6"
" " " H. P. " "	5"
Outside lap of L. P slide valve	¾"
" " " H. P. " "	¾"
Inside clearance of L. P. slide valve	⅜"
" " " H. P. " "	$\frac{1}{16}$"
Lead of L. P. slide valve in full stroke	$\frac{3}{16}$"
" " " H. P. " " " "	$\frac{1}{16}$"
Throw of upper end of reverse lever from full gear forward to full gear backward, measured on the chord of the arc of its throw	4' 3"

WHEELS, ETC.

Diameter of driving-wheels outside of tires	4′ 6″
" " truck-weels	2′ 6″
Size of main driving-axle journal, diameter and length	8″ × 9′
" " other " " " " "	8″ × 9″
" " truck-axle journals, diameter and length	5″ × 9″
" " main crank-pin journals, diameter and length	6″ × 5″
" " " coupling-rod journals, diameter and length	4¼″ × 6″
" " other " " " " "	3½″ × 4½″
Length of driving springs from center to center of hangers	3′ 1″

BOILER.

Description of boiler	Reduced shell.
Inside diameter of smallest boiler ring	4′ 10⅜″
Barrel of boiler	Steel.
Thickness of plates in barrel of boiler	9/16″ and ⅝″
Horizontal seams	Butt joint, double lap, sextuple-riveted.
Circumferential seams	Double-riveted.
Tubes	Iron.
Number of tubes	233
Diameter of tubes outside	2″
Distance between center of tubes	2¾″
Length of tubes over tube-plates	10″ and 10½
" " fire-box	9′
Width of fire-box	2′ 8⅜″
Depth of fire-box; front	6′
" " " back	5′
Water space side of fire-box	4″
" " back of fire-box	8½″
" " front of fire-box	4″
Outside shell of fire-box	Steel.
Thickness of plates of outside shell of fire-box	½″
Material of inside fire-box	Steel.
Thickness of plates inside of fire box	5/16″
" " " back end of fire-box	5/16″
" " crown plate	⅜″
Tube plates	Steel.
Thickness of front tube plates	½″
" " back " "	½″
Crown plate	Radial stayed.
Diameter of dome	2′ 6″
Height of dome	2′ 2″
Maximum working pressure per sq. in	15′
Grate	Rocking.
Width of bars over fingers	1′ 2″
Width of opening between bars	¾″
Grate surface	24.2 sq. ft.
Heating surface in fire-box	161 sq. ft.
" " of the inside of tubes	1,311 "
Total heating surface	1,472 "
Nozzle	Single blast.
Diameter of blast nozzle	5″
Smallest inside diameter of chimney	1′ 3¼″
Height from top of rails to top of chimney	14′ 7″
" " " " " center of boiler	7′ 7″

TENDER OR TANK.

Weight of tender, empty	28,800 lbs.
Number of wheels under tender	8
Diameter of tender wheels	2′ 7″
Size of journals of tender axles, diameter and length	4¼″ × 8″
Total wheel base of tender	15′ 9″
Distance from center to center of truck-wheels of tender	5′ 1″
Water capacity of tank (in gallons of 231 cu. in.)	3,600.
Coal capacity of tender or fuel bin	7 tons.

ENGINE AND TENDER.

Total wheel base of engine and tender	48′ 4″
" length of engine and tender over all	59′ 4¼″

COMPARISON OF ENGLISH AND AMERICAN LOCOMOTIVES IN THE ARGENTINE REPUBLIC.

THE following extracts are from a report made to the President of the Department of Engineers of the Argentine Republic by Juan J. Elordi, Mechanical Inspector :

" In compliance with the President's mandate we take pleasure in making our report respecting the reasons which have caused this department to affirm that the rolling stock of the Southern Railway is not suitable for the service intended.

" To enable us to expose the defects more clearly, we have found it necessary to make a comparative study of this and the rolling stock from the United States, owned by the Western Railway, which was acquired when this enterprise was the property of the State.

" All the rolling stock of the Southern Railway was manufactured in England. As regards quality of material and its strength, it is all that could be desired ; but the builders did not take into account the character of road-bed and track on which it was to run, and, therefore, made it too heavy and the wheel base too rigid.

" The locomotives might run well enough on European roads, which are substantially built and well ballasted ; but such is not the case in this province, where most of the railways are built on loose soil, especially those of this company, and subject to frequent inundations.

" The result is a large increase in the cost of maintenance of way and repairs to rolling stock, and consequently a heavier burden on the income of the road and a proportionate reduction of interest on capital.

* * * * * * *

" *Class* 5.—These locomotives were intended for the express trains running between Buenos Ayres and Mar del Plata, but the results of their trial trips were so unsatisfactory that the Company was compelled to use them for ordinary passenger service. . . . They have a single driving axle (Crampton system), and the adhesive weight upon it is 29,392 lbs., or 14,696 lbs. upon each wheel. This, even with a working pressure of 160 lbs. per square inch, is insufficient to obtain the adequate tractive power.

" Practical experience has demonstrated that the locomotives built for this service should have two coupled axles, and an average weight of not less than 8 tons upon each wheel, to afford adequate tractive power. . . .

" Examining the weight of the locomotive, the unequal distribution upon each axle will be noticed, and the effects of this will be noticeably injurious to the permanent way. . . .

" *Class* 6.—Of all the locomotives owned by the Company these are the most suitable for the road, but even these show the weight imperfectly distributed, there being an excess of more than 10,873 lbs. on the bogie. The system of supports is inferior. While the absence of equalization permits of replacing the springs more readily, it has the disadvantage of making it impossible to distribute the shock due to the inequalities of track. They have, moreover, a swing-bar which connects the two fore-springs—a system that has been abandoned owing to its inefficiency.

" The excessive pressure at which the boilers are worked necessitates frequent and important repairs, such as the renewal of most of the tubes and stacks. The tube-plates and the fire-boxes are destroyed in a short time, notwithstanding the good quality of the material, owing to the high pressure of 160 lbs. per square inch, although higher pressure should be admissible without doing injury.

" All this is well proven by the cost of repairs, which amounts in two years to the sum of $1,800 gold.

" *Compound Class.*—It is evident that this system of locomotives for passenger trains was adopted without proper consideration of the conditions of service. Their greater weight, as compared with the high-pressure locomotives, the repairs required by them, the qualifications of the men who were to run them, should have been taken into account. . . .

" How small the economy of fuel realized in these over the consumption of the high-pressure locomotives may be seen by comparing the consumption of the latter with that of the locomotives of the Class 6.

" The distribution of weight of this type is also very unequal, making a difference of over 13,466 lbs. in excess upon the bogie—a very notable excess, since the average weight per square centimeter of surface of the road is 638 lbs.

" The pressure required in the boilers of these locomotives is 175 lbs. per square inch, this being necessary to obtain useful work ; but this has the inconvenience of necessitating continuous and serious repairs to the boiler. The journal-boxes are repaired and replaced very frequently owing, to the rigidity of the springs, and, as if this were not enough, the cylinders are very easily striated, according to the engineers of the Company, by the heavy weight of the piston, but due, in our opinion, to a blunder of construction which prevents the stem or rod of the piston from keeping its center in relation to the axis of the cylinder. The intercepting valve with which these locomotives are fitted and which helps them to start with the low-pressure cylinder in case the piston of the high-pressure cylinder is at the dead point, must work automatically—that is to say, it must put the boiler in communication with the low-pressure cylinder when the locomotive stops by means of a small auxiliary pipe. But it happens that it never works with regularity, and we have noticed in many cases that it requires from 8 to 10 minutes to start the train, having to back or reverse in order to effect this, a circumstance which generally causes the breaking of the traction hooks and bars, without taking into account the annoyance to the passengers from the heavy jerks, or the delays occasioned by the time required to take out the damaged vehicles and transfer the passengers. . . .

" These locomotives can only be examined from the standpoint of their weight and the bad distribution of same. . . .

" *Class* 7, *Compound A.*—These locomotives have the same defects as those of Class 6, but in the consumption of fuel they are worse. The distribution of the load over the axles is very unequal, there being in this case a difference of over 7,508 lbs. more on the bogie, the load being the heavier, as it has only one axle. In these, as in the previous ones, the repairs are very expensive, as may be seen from the detailed data given above.

CARS.

"Most of the cars of the Southern Railway have three axles and are very heavy, especially the sleeping-cars, which have a dead weight of 3,118 lbs. per passenger. The last cars recently placed in service consist of two classes of parlor cars, having each four axles on two bogies; but these are also very heavy compared with the American cars. . . .

"The passenger vehicles acquired might form a museum, such is the assortment of different models, only the difference in their outlines among the most modern being very remarkable. The first-class parlor cars (Class L 1) lately arrived have very narrow lateral doors, are very heavy, and in the interior decorations there is a censurable profusion of mirrors, which will be easily broken or scratched, thus requiring frequent renewals. It would have been more dignified and economical to have used veneered wood in their stead.

"The sleeping cars (Class F 4), besides being heavy, have an unpleasant movement, and if to this the bad condition of the road is added, we can easily imagine the annoyance to the passengers. The beds or berths are very narrow, and with the heavy jerks of the car it is almost impossible to remain in them.

"The seats in the second class cars (Class L 3) are not in accordance with the provisions of Article 58 of the 'Decreto Reglamentario' of the Railway Law, which provides that each passenger should be furnished with a seat 19½ in. wide in front and 15¼ in. deep. Instead of this a seat is placed on one side for three passengers, measuring only 54½ in. in front, and another on the other side for two passengers measuring 35½ in. in front. . . .

SLEEPING-CARS.

"The President has been able to appreciate correctly the good conditions of these cars as regards their running and the comforts they offer; however, it would be advisable to indicate to the Company how advantageous it would be to give to the beds of the large compartment the whole width of the seat (1 meter), as those of the American cars; it would be also desirable to suppress the lavatory at the end of the car, and to leave only the water-closet, adding to it a urinal, and arrange the doors so that they should not make, as they do now, that noise which is so annoying to the passengers. For the rest we find the reform highly practical, and it shows a perfectly well-finished work.

"The idea of reforming the three-axle sleeping cars so as to make one car out of every two cars, by erecting or supporting it on bogies, deserves the full approbation of this section, saving the little defects mentioned in the preceding paragraph.

AMERICAN ROLLING STOCK.

"The American rolling stock is much more suitable for our roads, because of the similarity in the construction and the nature of the ground of the United States and our country, and because of its simplicity, reduced weight, and improved system of equalization. Moreover, it costs less, and necessitates much less expense for keeping it in repair than the European stock.

"The American locomotives owned by the Western Railway, which were acquired when this road was the property of the State, by the engineers Messrs. Miguel Tedin and Louis Rapelli, are 10 for rapid trains, eight for freight trains, and 12 for switching, and were built at the Baldwin Locomotive Works, of Philadelphia, in 1889. The same works built in 1884, 30 locomotives for mixed trains for the railway of this province.

"The construction of these 60 locomotives, notwithstanding their simplicity, is first class, except in a few small details, which by no means affect their good conditions for service. The 30 locomotives for mixed trains have withstood very severe tests during the period when the railway had not the number necessary for its service, as, notwithstanding the excessive amount of work imposed upon them, the results have been very satisfactory and economical.

AMERICAN LOCOMOTIVES.

"*Class* 11.—(By the Baldwin Locomotive Works, 1884.)—It would suffice to compare the above data [not given here] with those of the Southern Railway locomotives to realize the superiority of these locomotives as regards the good distribution of the weight, cost of engine, and cost of repairs.

"The repairs they require are inconsiderable; their boilers continue in perfectly good condition, and in nine years' service it has been only necessary to renew the tubes of 15 locomotives, the fire-boxes and the tube and boiler-plates being in good condition. The system of equalization is superior, having equalized levers to connect the springs on each side, and the results have been good, even at a time when the road was in a bad condition.

* * * * * * *

"*Class* 14.—(By the Baldwin Locomotive Works, 1889.)—In tractive power the American locomotives are first-class, and with trains composed of 25 parlor cars they have developed a speed of 50 to 60 kilometers an hour, and a higher speed could have been attained, had it been desired and had the state of the road permitted. The distribution of the weight over the axles is even in all, and this is one of the good features combined in them. So far their boilers, during their three years' service, continue in a perfect state of preservation. The repairs they have to undergo are inconsiderable and confined only to the renewal of the bearings and the turning of the tires.

"*Class* 15.—(By the Baldwin Locomotive Works, 1889.)—These locomotives, like the preceding, are very good; their work and preservation are unsurpassed in good results. The weight on the axles is also even in all of them, this being one of their best features for our roads.

"It may be concluded, from all the data furnished in this report, that the Southern Railway locomotives are but iron masses, entirely injurious to the roads and interests of the Company, and that a large part of its rolling stock is unnecessary for the service of its lines, as neither the condition of its road nor the necessities of its traffic require it. . . .

"So unfavorable has been the result of the compound locomotives (Class 6 A) that it was necessary to withdraw them from the Mar del Plata service last summer, and to use in their place the freight locomotives, owing to the tractive power of the former being less than was required. We think that the foregoing report is sufficiently specific to enlighten the President, and to justify us in asking him to decree that no company be allowed in future to import in this country their locomotives without first presenting and submitting their plans to the approbation of this Department.

CARS.

"It will suffice to cite the principal features of the American cars to establish their superiority over those built in England. As the outside of the former is all made of first-class white pine, their cost is reduced without sacrificing their strength, and they are made lighter thereby."

[Here follows a description giving the weights, capacity, number of axles, and cost of the different classes of American cars, which is not reprinted.]

"The preservation of this rolling stock is very economical, and they are now in perfect condition after four years' service. The dead weight per passenger is one-half less than that of the English cars, excepting the sleeping-cars, in which the difference is only of 913 lbs., having four axles instead of three, as the others have. The system of bogies is the best for our roads, because having no lateral movement they do not injure the road; whereas those having three axles require said movement to run over the curves.

"Trusting that we have fulfilled the task imposed upon us to the satisfaction of the President, we respectfully salute him.

(Signed) "JUAN J. ELORDI,
"*Mechanical Inspector.*
"FCO. ESTEVES,
"*General Sub-Inspector.*"

Of the above it may be said that the English builders of the locomotives and cars *could* have made machines and vehicles better adapted to the requirements of the roads in the Argentine Republic, but the fact that they did not do so seems to be abundantly shown by the above report. The fact is that the requirements of our American railroads have resulted, quite naturally, in the evolution of a system of rolling stock adapted to their environment. The conditions existing in the Argentine Republic and other parts of South America resemble much more nearly those which prevail here than those which exist in England, therefore quite naturally our locomotives are better suited to the roads in that continent and other new countries than the English machines are without modifications. It has been said that doubtless the Lord could have made a better berry than the strawberry had He chosen to do so, but apparently He did not so choose, and therefore the strawberry maintains its pre-eminence. So it may be said that the English builders of the Argentinian locomotives and cars might—perhaps—have made better machines than they sent to that republic, but apparently they did not choose, or did not know how to do so, and therefore the united scream of the American locomotive and the American eagle has again silenced the growl of the British lion in our sister republic of South America. Hip, Hip —— !—EDITOR AMERICAN ENGINEER.

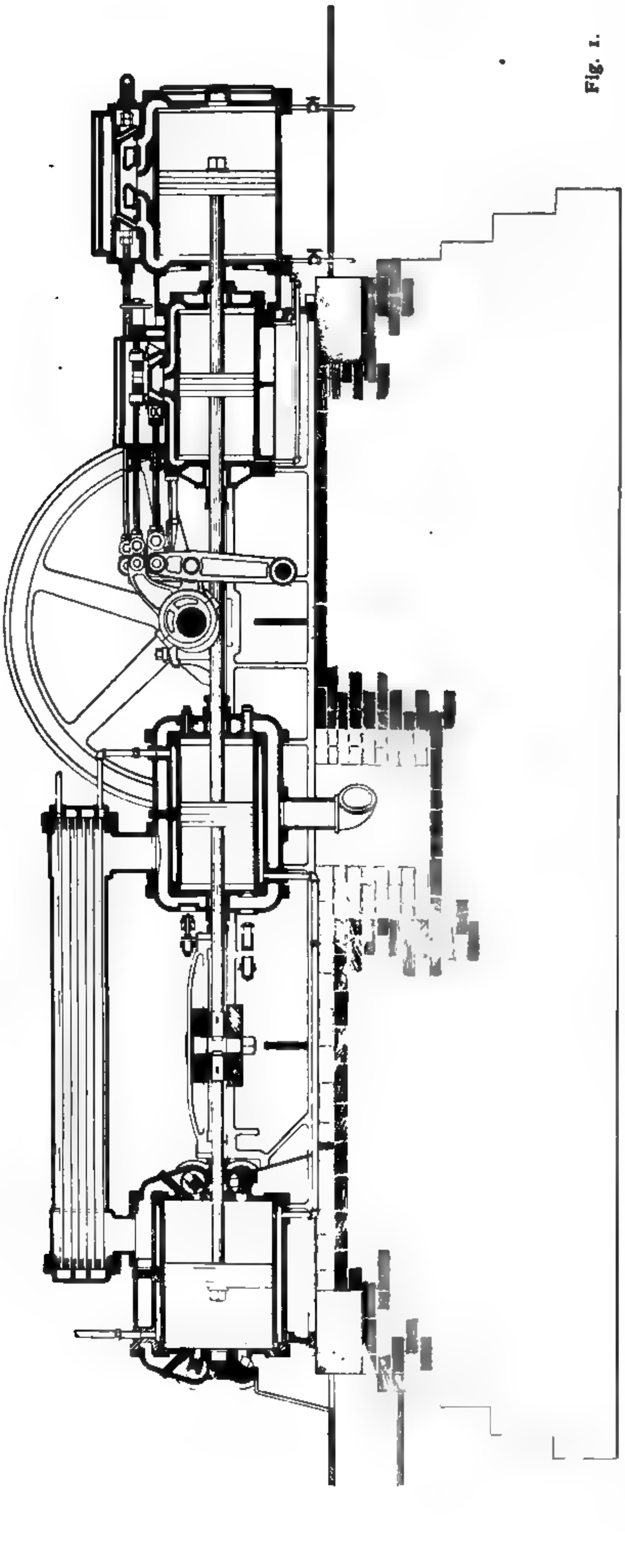


Fig. 1.

COMPOUND, AIR COMPRESSOR, BUILT BY THE SOUTH NORWALK IRON WORKS.

THE NORWALK COMPOUND AIR COMPRESSOR.

In our recent issues we have been publishing illustrations of several types of hydraulic and pneumatic hoists for machine shop use. On another page of this issue we publish an illustrated description of the pneumatic hoisting arrangements that are in use in the New Haven shops of the New York, New Haven & Hartford Railroad. The use of compressed air is meeting with a wider and wider application every year, and its utilization as means of transmission of power has been widely applied in Paris, and it is probable that the same means will be used at some of the plants at Niagara Falls. As the pump is a necessity for hydraulic work, so the air compressor is the basis from which this pneumatic work must start. The compressor which we illustrate is one of the standard type which is built by the South Norwalk Iron Works, of South Norwalk, Conn., and presents some novel and interesting features. In the construction of this compressor the objects aimed at were to make the resistance of the air to compression an average resistance throughout the stroke instead of being a maximum and excessive resistance at the end; to reduce the losses and clearance spaces to the smallest possible amount by having the pressure in the intake cylinder a light one, and finally to have the advantages of two water jackets and more time for cooling the air. After the introduction of the compound compressor, in which the larger cylinder compresses air into the small one, the next change in the development of the construction was the addition of an intercooler between these cylinders, which is shown in section in the engraving as connecting the two cylinders. This intercooler consists of a large pipe reservoir filled with thin brass water pipes. As the air passes to the second cylinder it becomes divided into thin streams by these pipes, and thus every portion of it is brought into close and immediate contact with the cold surfaces of the pipes, and the temperature is very rapidly reduced. In addition to the advantages which were obtained from the mere cooling of the air and the consequent avoidance of the excessive temperature resulting from compression, it was found that this intercooling between the cylinders produced economic results which were somewhat unexpected. The reason for the economy obtained is that when compression takes place in the large cylinder the air is heated, and if this were allowed to pass directly to the compression cylinder it would fill it with air at a given temperature and volume. Therefore, if this temperature is reduced the actual volume of air introduced into the second cylinder would be increased and the capacity of the machine correspondingly augmented.

Up to the time of the development of this machine we believe that all of the inlet valves were of the poppet type. The change was made by first introducing a Corliss valve for the inlet valve. These valves were opened and shut in connection with the main engine, and no vacuum was required in the air compressor to insure their working. The next step was in making a direct valve connection between a return crank on the engine and the valves, and also making a direct connection between the openings of these valves and a conduit which came in beneath the floor from the outside atmosphere, so that air which was naturally as cool as possible was introduced into the first cylinder,

thereby avoiding the extra temperature which would naturally arise when air is taken from the engine room. This change alone is said to have secured a saving of about 1 per cent. for every 5° lower temperature obtained. The cam gives a rapid movement, so that the valve is seated before any considerable pressure comes upon it. The connection that throws it shut is elastic, so that if a valve becomes dry it does not cut. The ordinary poppet valves are objectionable

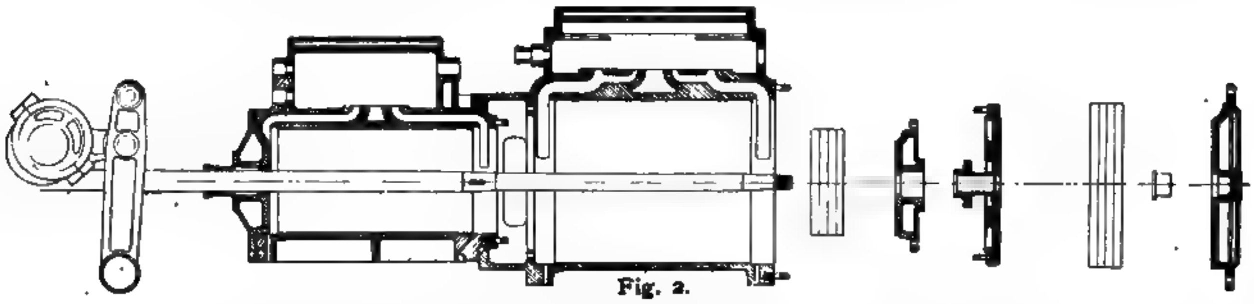


Fig. 2.

SECTION OF STEAM CYLINDERS—ARRANGEMENT OF STEAM CYLINDERS.

Corliss inlet valves having been such a success they were next introduced as delivery valves for the low-pressure cylinder, as shown in the longitudinal engraving which we present. While the pressure which is delivered from the low-pressure cylinder (being only about 25 lbs.) is so light that its effect on

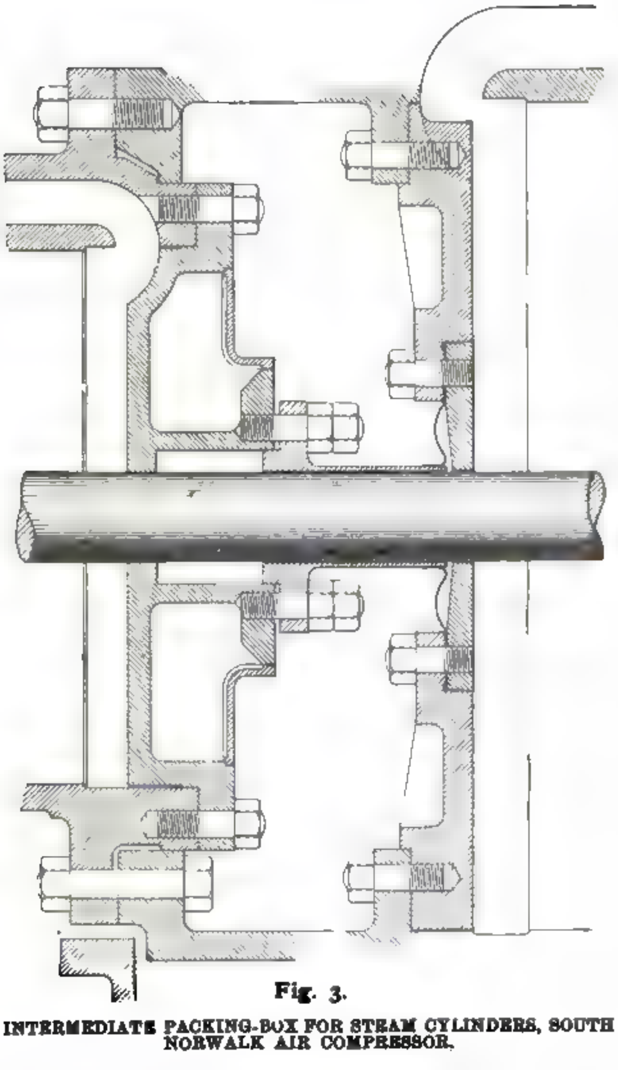


Fig. 3.

INTERMEDIATE PACKING-BOX FOR STEAM CYLINDERS, SOUTH NORWALK AIR COMPRESSOR.

the wearing of the Corliss valve was considered of little consequence, no change was made in its construction; but when there came a demand for compressors delivering pressures up to thousands of pounds to the square inch, it became necessary to use a higher pressure in the inlet cylinder. The valves are therefore now moved by cams, the shape of which are such that the valve remains at rest until the pressure below it is nearly equal to that above it. Then the movement commences, and the valve is quickly forced wide open. In closing, the when used for inlet valves, because in order to insure a prompt action when the valves become sticky with gum, oil, or other substances, it is necessary that the springs should have a force of not less than 8 oz. per square inch, and while this has but little effect upon a pressure working at the sea-shore, at high altitudes it is a very considerable detriment; and also, though the vacuum may be inappreciable when measured by the ordinary vacuum spring, it is considerable when 4 lb. springs are used, and may amount to as much as nearly 8½ per cent.

To quote the ideas from the Norwalk Company's catalogue, the ideal compressor, in order that the work may be constant, should have a conical cylinder, so that the light pressure exerted upon a large piston at the beginning of the stroke would be equal to the heavy pressure exerted upon a small piston at the end of a stroke. This is practically impossible to construct at present, and the compound cylinder, as now built, affords as near an approach to this as is possible to obtain. In order that the application of power may be uniform during the whole stroke, the pistons and cross-heads of all four cylinders are connected to one rod; and as these parts have considerable weight, which requires most of the power of the steam over and above the air resistance at the beginning of the stroke to start them forward, so, at the end of the stroke, when the steam pressure is weak and the air pressure high, the power stored in the momentum in these reciprocating parts is given out in useful work, and the parts are brought to rest by expending their force in compressing air. As the energy thus stored depends on the weight of the reciprocating parts and on the square of the number of revolutions, it is evident that rotating speed is a very important factor to take into consideration. Therefore short strokes are used. The use of the fly-wheel is merely to regulate the steam-valve motions and to control the length of the stroke and even up and balance any inequalities which may result from the relations of power to resistance and secure a uniform speed for the machine. Surface condensing is used entirely, and no water is allowed in the cylinder. The advantages of surface cooling in comparison with that of water in the air cylinder are several. The first consideration is that the compression with surface cooling is dry. This is an important matter, for when air is heated by compression and brought into contact with the water, it is apt to become saturated with moisture. It is well-known that when air is exhausted after doing its work, it is apt to have a temperature far below zero, so that it quickly freezes all moisture in the air and deposits it as ice in the exhaust passages of the air engine, which will therefore become quickly closed. The natural remedy is, of course, to keep the air cool. It is estimated that if 100 H.P. were required to deliver a certain amount of air at 60 lbs. pressure without having any cooling apparatus connected therewith at all, a saving of 21.6 per cent. would be made if a perfect cooling apparatus could be added to the compressor.

There are one or two details in regard to the construction of this compressor which are exceedingly interesting. The longitudinal skeleton section which we give of the machine, fig. 2, shows the general arrangement of the steam cylinders. The great difficulty which is ordinarily experienced with a tandem compound steam engine is that, when it becomes necessary to remove the piston-head of the forward cylinder, it is necessary to take out everything behind it, and when the heads are so arranged that they cannot be readily removed, it is frequently necessary to back off the rear cylinder and separate it from the machine. When this is not done it is frequently necessary to uncouple the piston-rod from all its connections and back that out in order that the heads may be removed. The compound cylinders which we illustrate here are made tandem with the

high-pressure cylinder toward the center of the piston-rod. The low-pressure cylinder comes up close against it, and the flanges, cast on the cylinder itself, bolt against flanges on the high-pressure cylinder. The heads are put in from the rear end of the low-pressure cylinder, and they are shown in section at the right of the engraving. It will be seen that the high-pressure piston can be slipped over the rod and the latter backed down until the key-way comes near the open space between the two cylinders. The key can then be driven home and the piston rod adjusted without any trouble. Next the head of the high-pressure cylinder is slipped into position over the rod through the low-pressure cylinder and bolted upon the studs, the wrench being easily worked in between the cylinders. The next step is to put in the head of the low-pressure cylinder. It will be seen that this, instead of flanging up on the outside, is bolted to an internally projecting flange and comes up on the inside of the cylinder, being cut away on the top for the steam port, so that it does not interfere with the admission of steam in the slightest. The low-pressure piston is then put on and held with a nut, as shown, and finally the back-head is bolted on the same like any ordinary cylinder-head.

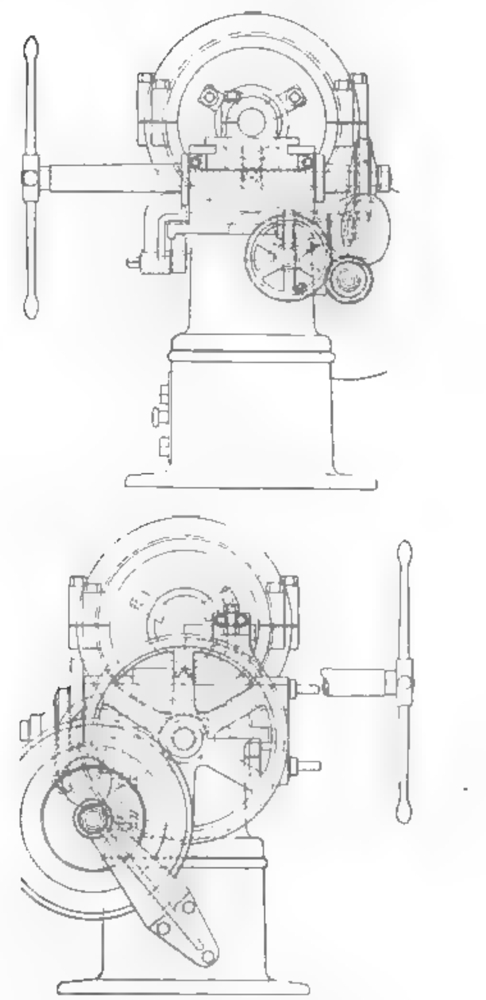
Another novel and exceedingly interesting detail of these cylinders is the construction of the packing-box between the two cylinders. This is also shown in detail in our engraving, fig. 3. Every engineer who has had to do with tandem compound engines knows the difficulty of packing and keeping packing tight in the stuffing-boxes between these two cylinders; and designers are well aware of the difficulties which constantly confront them of shortening the total length over all of tandem compound cylinders, and still have sufficient room between the cylinders for the stuffing-boxes and the proper handling of the same. Some have even gone so far as to use a head with a corrugated piston-rod without any stuffing-box whatever; but the construction of the Norwalk engine is certainly unique and worthy of careful attention. It will be seen, from an examination of the engraving, that there is but one stuffing-box, and that on the head of the high-pressure cylinder. This stuffing-box is of the ordinary type, and carries a metallic packing which can be easily adjusted with a very slight motion of the gland. The gland is bored out so as to fit the piston-rod snugly, and extends back to a point close to the low-pressure cylinder head. It is there connected by a copper plate, as shown, which comes up against the head and is held by a clip as shown. It is firmly attached to the gland. This has strength enough to resist the steam pressure existing in the low-pressure cylinder, and yet has the flexibility enough to allow the gland of the high-pressure stuffing-box to be moved backward and forward all that will be required for ordinary adjustments. It will thus be seen that the packing on the high-pressure stuffing-box is subjected to two pressures. The low-pressure cylinder pressure runs beneath the gland and works on the outside, while the high-pressure steam follows the piston-rod between the head and comes against the packing on the inside, the latter separating the two and effecting a perfectly tight joint.

The other details of the engine which are attached to these standard compressors are so designed as to attain the highest economy possible. The steam cut-off valves have a wide range and are quick in their action, giving a clear point of cut off and a very perfect expansion line. The cut off is changed by turning a hand-wheel placed at the back end of the high-pressure steam chest, and it is easily accessible. The point of cut off can be changed while the machine is in motion to meet any requirements of speed. Its position is shown by an index, and the experience which has been gained in the construction of these compressors show that the engine is particularly well suited for the duty which it is called upon to perform.

PROJECTILE TRIMMING MACHINE.

We illustrate a projectile trimming machine, which has been built by the Bridgeport Machine Tool Works, of Bridgeport, Conn., for the United States Projectile Company, of Brooklyn, N. Y. The tool is made especially heavy, and is intended for trimming off the ends of shells after they have been taken from the presses in which they have been formed. The principal and prominent feature of the machine is the chuck, which stands near the center of the bed. This chuck is driven by a gear-wheel meshing in with a pinion that is keyed to the main shaft, which runs along the length of the machine in the center of the bed. The teeth run close to the casing, and there is a short bearing on the outside of the same. In order to save end room and to be able to bring the edge of the cutting tool close up to the chuck, the dogs for holding and centering the shell are set into the face of the chuck. These are of the independent type, and are set for each size of shell. When it is necessary to remove the shell, one is slackened off, the shell removed and another slipped into place, when it is again tightened down. They are, as we have already said, flush with the face of the chuck, so that they are out of the way while work is being done.

The machine is driven by a 4 in. belt running over a three-step cone at the end of the machine, as shown. The shaft of the cone carries a pinion meshing in with a large spur-gear on the end of the main shaft. The tool posts are carried by extra strong and heavy carriages with cross-feeds. The end carriage has an arrangement for holding a boring-bar that is used for turning out the inside of shell, so that when the latter is once in position it can be finished without being removed from the machine. The feed-rod runs along the back of the machine and carries worm-gears for operating each carriage. The chuck is geared 19 to 1 with the cone shaft, and the revolutions of the chuck may be varied from 12 to 50 per minute with four intermediates—namely, 16, 21, 28, and 37. The cross-feed is .01 in. per revolution, and the boring-bar feed is the same. It will be seen from the engraving that the bed is exceedingly strong, and that all parts are so proportioned that they are capable of doing the heaviest work. This is merely



END ELEVATIONS OF PROJECTILE TRIMMING MACHINE.

one of the many special types of machines which have been built by the Bridgeport firm for doing particular kinds of work.

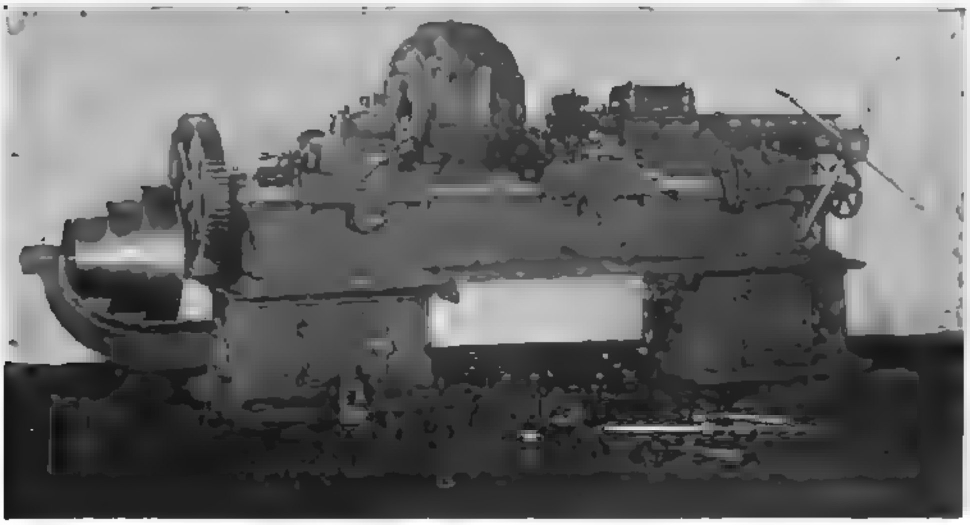
MEETING OF MEMBERS OF THE SOCIETY OF MECHANICAL ENGINEERS.

Some of our readers will remember an editorial article which was published in The American Engineer of last September, with the title "Monthly Meetings of Mechanical Engineers for Technical Discussion." This article was afterward reprinted on slips, with a note appended, asking members of the Society "who feel an interest in the scheme of

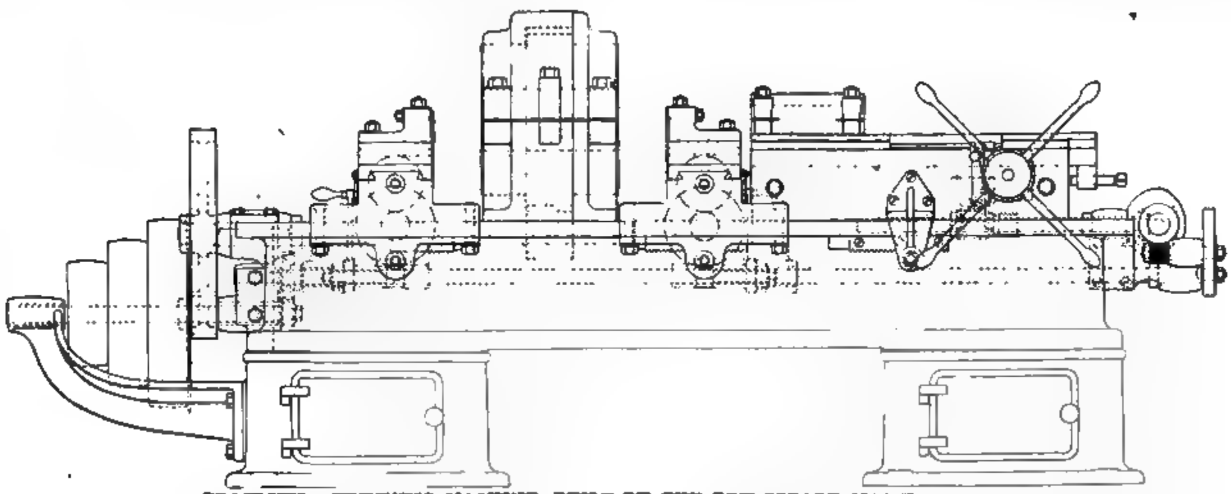
holding such monthly meetings for the discussion of technical subjects as were suggested in the article to signify their approval or disapproval of it by communicating with the editor of The American Engineer." A copy was then sent to each member of the Society. About 50 replies were received, all approving of the scheme proposed. As a sequel to this a meeting of a few of the members of the Society was called, and met in its hall on November 1, and the following resolutions were adopted:

"*Resolved*, That it is the sense of this meeting that it would be desirable and profitable that an opportunity be given for members of the American Society of Mechanical Engineers to meet at convenient times during the coming winter and spring for the discussion of subjects pertaining to Mechanical Engineering.

"It is further resolved that a committee of five be appointed to arrange for such a series of monthly meetings during the coming winter and following spring, that it be authorized to select and appoint a chairman to preside, to fix dates for holding, and to issue calls for such meetings, select subjects for consideration and speakers to present and discuss them, arrange the order of proceedings and make all necessary rules for the conduct of such meetings, solicit subscriptions and audit and pay all bills incurred for such expenses and fill vacancies which may occur during the period named."



PROJECTILE TRIMMING MACHINE, BUILT BY THE BRIDGEPORT MACHINE TOOL WORKS.



PROJECTILE TRIMMING MACHINE, BUILT BY THE BRIDGEPORT MACHINE WORKS.

The Chairman of the meeting, Mr. M. N. Forney, was made permanent chairman of the above Committee, and he was authorized to appoint four other members to act with him. Commodore C. H. Loring, Mr. C. W. Hunt, and Frank Ball were appointed to act with the Chairman, leaving still one vacancy. After deliberating on the subject submitted to their consideration the Committee issued the following call for a meeting:

To Members of the American Society of Mechanical Engineers.

"In accordance with the duty delegated to them the Committee have selected the evening of the second Wednesday of each month as the time and date for holding such meetings. The first one will be held on Wednesday evening, January 10, at 8 P.M. The subject which will be considered will be the Development of Stationary Engines as illustrated by those exhibited at the Columbian Exhibition in Chicago. Mr. F. F. Hemenway, editor of *The American Machinist*, who spent considerable time at the Exhibition, will give a short talk—not a formal paper—on the subject, which will not exceed 30 minutes in length, after which the subject will be open to general discussion, the speakers to be limited to five minutes' time, and none to speak more than twice, until all who wish to do so have spoken. Builders of stationary engines are especially invited to take part in the discussion, and if the Chairman of the Committee is advised before the meeting of their intention to do so, time and places after the opening talk will be assigned to them. Such persons are also invited to send photographs, drawings, or models illustrating interesting features or recent forms of construction of stationary engines, for examination by those in attendance.

"It was agreed by the Committee that all members of the Society may have the privilege of introducing or bringing friends to the meetings, who may with the consent of the Chairman take part in the discussions. It is hoped that the proceedings will prove to be of sufficient interest to strangers so that mechanical engineers of distinction visiting in New York will always be brought and introduced at these meetings.

"It is expected that Mr. C. W. Hunt will preside on the evening of January 10. As this first meeting will, to a very great extent, be an experiment, it is very desirable that it should be successful. Members in sympathy with the movement are therefore earnestly invited to be present, and to do or say something which will add to the interest of the proceedings."

In response to this call about 50 members assembled in the hall. The meeting was called to order by the Chairman of the Committee, who then said:

Members of the Society of Mechanical Engineers:

In opening this meeting perhaps a few introductory words are needed, and as in presenting a stranger to a friend we usually say a word or two to make the antecedents and origin of the stranger known, so it may, perhaps, be expected that

those to whom the duty has been delegated of inaugurating these meetings will say something of their origin and purpose. To some of us it has seemed very desirable that more frequent opportunities should be given to the members of this Society of coming together, for the consideration and discussion of subjects in which we are all interested, than the regular meetings of the Society provide. During the past few years some effort in this direction has been made, which gave those of us who were interested in the movement sufficient encouragement to make another effort in this direction. To explain why those meetings which were held at irregular intervals were not continued, it may be said that what may be called the installation of such meetings is not as simple and easy as those persons who have never undertaken it are apt to think. The difficulties and labor involved in preparing for such conferences are very considerable In holding a meeting at which there will be interesting discussions there must, in the first place, be some subjects to discuss. Without such subjects the meetings will be flat, stale, and unprofitable. Now not every topic that can be thought of will be productive of discussion. If the members were invited to come here and ponder over the intensity of pressure per square inch exerted by locomotive driving-wheels on rails, probably it would not stimulate much talk, because very little is known of that particular subject. To have a good meeting you must have a good subject, and this implies that some one must use his knowledge, refer to his experience, and exercise his wits to select one which will be prolific of discussion. Having done this, there must be some one to talk about it. Now those of us who have had experience in what may be called the dynamics of meetings have found that there is a great deal of inertia in men's minds, and that generally some stimulus must be provided which will make them think and talk. If you bring a body of men together and ask them to make remarks on an abstruse subject, without first giving them some stimulus—I do not refer to the liquid form—you may have a sort of Quaker meeting as the result. There must usually first be something to excite the minds and the tongues of those in attendance. Not only a subject must be selected, but one or more speakers must be provided, a chairman must preside who will call out the timid and suppress the wind bags, rules must be made, notices sent out, and many other details attended to. At previous meetings which were held no adequate provision was made for this kind of supervision. The members of this Society have learned to depend upon their Secretary to such an extent that they are apt to think that any duty may properly be imposed on his shoulders. It will not be out of place here to say that the general supervision of a series of meetings, such as are now contemplated, is not distinctly the duty of the Secretary, and ought not to be imposed on his shoulders and added to his other multifarious tasks. If any of you have ever acted in the capacity of a Secretary you will realize this. The responsibility for the previous meetings, which have been referred to, was to a great extent placed almost entirely on his shoulders. Some of us who thought that a continuation of those meetings would be interesting and profitable and in every way desirable, felt that this additional labor ought not to be expected of our worthy Secretary, while at the same time we also felt that it would be very desirable to continue the meetings which had heretofore been held at irregular intervals. A few of us assumed the responsibility of first issuing a circular asking the opinion of members with reference to holding such meetings.

A large number of replies were received from which some extracts were read.

Encouraged by the responses to the circular, a meeting of a few members was called and held in this room on November 1, at which the resolutions printed above were adopted, and the Committee named above was appointed.

At the outset the Committee encountered a feeling which exists among some of our members, which is that it would be injudicious to hold any meetings of the Society itself, excepting those at the annual meeting and annual convention. It is thought by some members that if a series of meetings are held in which most of the non-resident members cannot participate that it might result in dissatisfaction. The Committee therefore thought it would be wise to make a distinct disavowal of any intention of holding regular meetings of the Society. This was done in the following paragraph of their circular:

"In order to avoid misapprehension the Committee deem it best to explain that the meetings which it is proposed to hold will not be, in any sense, meetings of the Society, but only of such members as may choose to attend them. The proceedings will form no part of the transactions of the Society, and will not be published by it. The members who come to the meetings will merely be exercising their privilege of assembling in the Society's hall and discussing subjects of mutual interest."

The general idea which the Committee have had in mind was first to select some subject for consideration which would be likely to elicit discussion. Then to find some person with special knowledge of it to give an informal talk on it, and then open it for general remark and debate. It is hoped that the opening address will serve as a sort of a concentrator of thought and an excitor of discussion thereafter. It is the experience probably of many of you, as it has been mine, that the interest in meetings for the discussion of technical subjects is in a great many cases swamped by heavy, ponderous papers, the facts of which cannot be grasped, the theories comprehended, nor the intended deductions understood by those who listen to the reading of them. The Committee are agreed that papers of this character are not suited for meetings of this kind, and it will be their endeavor not to have any of the opening addresses or papers of such a character or length as to exceed the limit of elasticity of the attention of the audience.

The only rules which have thus far been adopted for the government of these meetings are:

1. The principal speaker of each evening to be requested not to occupy more time than 30 minutes.
2. Those who afterward take part in the discussion to be limited to five minutes, and no speaker to speak more than twice until all who wish to do so have spoken.
3. All members of the Society shall have the privilege of introducing or bringing friends to the meetings, who may take part in the discussion with the consent of the chairman.

I think I may also speak for the rest of the Committee in saying that it is not their intention to give these meetings a free-and-easy character. It is their purpose and hope to make these assemblages dignified meetings of the members of the leading engineering society of the country, to which we may all bring the most eminent and distinguished co-laborers in our own occupation from this and foreign countries, and when we do so, we want to be able to feel proud of our associates. It is hoped that to these meetings the mechanical engineers of this and other countries will bring the results of their ripest experience, their most profound knowledge, and share with each other those thoughts which they will want to leave behind them as part of the record of their lives and their labors.

Mr. C. W. Hunt, who had been invited by the Committee to preside at this meeting, was then introduced, and presided over the meeting.

The meeting was then opened, as was announced, by a paper by Mr. Hemenway on the Development of Stationary Steam Engines as illustrated by those at the Columbian Exhibition at Chicago, from which the following extracts are taken:

"To note progress, comparison must be made, and it is rather convenient, as well as common in this country to refer mechanical progress to the Centennial Exhibition. The interval between the Centennial and the Columbian Exposition —nearly 20 years—seems long enough for the purpose of fair comparison. Generally speaking, the steam-engine of 1893 will be found to be a better machine than that of 1876, made so by gradual advances, scarcely noticeable in some, and prominently so in other types.

"In the matter of compounding, compared with the Centennial, there was evidence of notable progress at Chicago. At the first-named exhibition there were no compound engines; at the last named, compound engines—two cylinder, triple and quadruple expansion—were the rule. Compounding is old, but at the date of the Centennial was not in repute for the more ordinary purposes for which steam-engines are employed. For such engines, at least, the economy of compounding was boldly disputed by some engineers, and more than questioned by others. Little doubt as to its superior economy exists to-day. Scarcely more than 10 years ago it was very easy to start a discussion between engineers as to the relative merits of simple and compound engines, as regards the economical use of steam. It is scarcely possible to do so now. That this is so is due to a better knowledge of the whole matter. The exhibits at Chicago, it seems to me, showed two things in relation to compounding, one of which was that progress has been made, and another that there is still room left for progress. There were some very fine examples, and some in which the effort to engraft the second cylinder upon the first was hardly felicitous. As one well-known engineer put it, the cylinders were not always neighbors, which may have covered other considerations than that of distance. But some undesirableness must be expected of anything in the transition state. A move in the right general direction, if not in the most direct line, represents progress compared with standing still.

"Comparison between the two largest engines—the Corliss at the Centennial and the Allis at Chicago—is unsatisfactory because of the difference in principle and in constructive de-

tail. One was a vertical and the other a horizontal, one simple, the other compound. Considered architecturally, to misuse a term for the sake of convenience, I should think there was nothing at Chicago that could compare very favorably with the Corliss at the Centennial. Probably in the best interest of progress there ought not to have been. In war there is perhaps nothing that will compare with the altogether useless charge of the Light Brigade. The Allis engine was of greater capacity, and, aside from this, it would, beyond doubt, furnish a H.P. for less expenditure of coal, and the chief end of a steam-engine is to furnish, all things considered, H.P. for little money. Both these engines were Corliss engines, as the term is employed at the present day, and the Centennial engine was certainly not behind in its mechanical performance. Nothing could behave more admirably as a machine.

"The most noticeable point of difference in the valve mechanism of these engines was the employment of a supplementary eccentric in the Allis engine for controlling the point of cut off. By the operation of this, the unlatching could occur at any point up to practically full-stroke. Objection, not very weighty, perhaps, but having some force, has frequently been made to the ordinary Corliss gear on simple engines because the steam-valves must be tripped, if at all, somewhat before the half-stroke of the piston. This objection, for obvious reasons, would have greater force in the instance of multi-cylinder compound engines. This second eccentric, as used, appears to be a desirable improvement. It is only proper, however, to say that the end aimed at by the use of this eccentric has for some time—and notably in England—been at least partially accomplished by the use of two eccentrics, one for the steam and one for the exhaust-valves. By this means it is possible to extend the point of unlatching until, practically, half-stroke, and this will prolong the expansion until about three-quarter-stroke, the piston at half stroke being at its fastest travel; this — three-quarter-stroke — is perhaps late enough for cut-off in any engine used for ordinary purposes.

"The time required for valve closure after unlatching in the Corliss type of engine was very well shown by an experiment made several years ago by some of the bright young students of Massachusetts Institute of Technology. This experiment was made with an 8-in. × 24-in. Harris-Corliss engine, by blocking the governor and loading the engine by means of a brake, then while the engine was running gradually, though comparatively quickly, releasing the brake friction, the pencil of the indicator being all the time in contact with the paper on the drum. By this means a series of diagrams were taken on a single card, the point of unlatching of the valve being, as explained, constant, while the speed of the engine increased as the load was decreased. The point of valve closure, as shown by these diagrams, was all the way from before half-stroke up to later than nine-tenths-stroke, the speed of the engine at the conclusion of the experiment being estimated at over 150 revolutions.

"It may be mentioned that gain in power, as shown by these diagrams, by prolonging expansion beyond three-quarter-stroke, was trifling, the increased forward pressure on the piston being nearly neutralized by an increase in the back pressure, although the steam line showed but little drop in pressure.

"It seems probable that there is some gain—and it is so stated by those familiar with the subject—in the use of separate eccentrics for steam and exhaust-valves through the possibility of a more advantageous arrangement of the exhaust-valves and their operating mechanism, as the steam-valves are not influenced by the change made in this respect. The use of separate eccentrics for steam and exhaust-valves, as referred to, was not, so far as I know, in evidence at Chicago, nor do I know when they were first employed. I am assuming that their use does not antedate the Centennial, in which I may be in error. They were, I am informed, so used by the E. P. Allis Company as early as 1886, but are not recommended by them except in the instance of the low-pressure cylinder of triple-expansion engines when it is desirable to carry expansion beyond half-stroke, and sometimes in the instance of two-cylinder compounds for the same reason. The chief reason why the two eccentrics are advised against by this Company is, I believe, the fact that the engine does not handle so conveniently when they are employed. I also believe, though I am not quite certain, that the Atlas Works, of Indianapolis, used two eccentrics something in the way indicated at an earlier date than that mentioned.

"Of the engines possessing to an extent greater or less some of the features of the Corliss, and designed to avoid what are claimed to be undesirable characteristics of this engine, not much can be said; the value of new arrangements of details should not be judged hastily, but time should be given in which to demonstrate their utility, or the contrary. Progress sometimes consists in going backward, which may or may not yet be illustrated in the instance of some of these engines at Chicago. There has, broadly speaking, been but little improvement in Corliss engines since the Centennial, and for some time previous to that. Some little modification of details has been made, undoubtedly in some instances of value, and a large amount of good material and workmanship, and a world of ingenuity have been wasted.

"One engine, the Bates-Corliss, was provided with a very neatly worked-out scheme for doing away with unlatching, at the same time preserving its equivalent. If unlatching is very objectionable, which I do not believe, this provides a way around it. As perhaps all of you know, there is in this plan a sort of doubling up, or back, in the steam-valve connection which is provided for by the operation of the governor; a sort of collapsing that may be likened to a toggle joint under pressure, forced beyond the center line and free to move further.

"This detail I suppose to be new, and it is, perhaps, yet to be demonstrated that something more objectionable than the unlatching of the Corliss motion is not developed by use. It appeared to work in every way satisfactorily.

"High-speed engineering cannot be said to have come into existence since the Centennial, but its growth has been mainly since that date. Previous to that the Buckeye Engine Company had built some quick-running engines for saw-mill work, I believe, and Mr. Charles T. Porter had built a few high-speed engines, and was engaged in missionary work, which he continued, and which has left his mark, if not as plainly written on rapid-revolution engines as that of Corliss on those of slow-revolution, quite as effectively perhaps, so far as results go. It is not necessary to mention the influence of the correct workmanship introduced by Mr. Porter, workmanship that made high speed practicable. All know of it, and thousands have profited by the example. In addition Mr. Porter originated a form of bed that has demonstrated a good many times that it is easier to modify and change something than it is to improve it. The outcome of his work—his example—was in indirect evidence at Chicago in the numerous examples of fine high-speed engines exhibited. Nothing like this exhibit would have been possible 15 years ago. This is particularly true of single-valve automatic high-speed engines with shaft governors, which have almost worked a revolution in some branches of steam-engine construction since the Centennial. There were, I believe, but two examples of stationary engines with shaft governors at the Centennial, the Buckeye and the small high-speed Straight Line by Professor Sweet. The latter has been so modified since then as hardly to be called the same engine. To these may be added the portable engine by Hoadley, making in all three engines with shaft governors. The portable engine named is not now built that I am aware of. These engines are referred to as showing the wonderful growth of this type of engine—those with shaft governors—as shown by contrast with the exhibits at Chicago.

"The discussion as to the relative merits of high and low-speed engines has been warm in previous years, the outcome of which is a pretty thoroughly settled conviction that each is best in its field, although the boundary lines are not very clearly defined. The high-speed engine has come to stay because it fills the proverbial "long-felt want," and the low-speed stays because its retirement would leave a void.

"Along with the requirement for better construction brought with the high-speed engine was that of improved methods of distributing oil. Getting a little oil, once in a while, where it would do some good, would not do, as the revolutions and reciprocations got way along up into the hundreds; getting the right quantity—or at least enough—at the right time, where it would do the most good, was demanded, and hence the ingenious arrangements to that end shown in connection with the engine exhibits at Chicago—all of modern growth.

"Something the same may be said of balancing. Correct practice in this respect was an essential of high speed, and a great deal of attention has been given to it and a good deal learned about it during the past 10 or 15 years. With the many examples of fine balancing shown at Chicago, it would be unfair to make special mention were it not for one instance of an engine—the *Ide*, I believe—which may be taken as an example of other practice; this engine was shown running very quietly, mounted on small wooden blocks—stilts.

"Great advances have also been made in controlling the speed of high-speed engines. So perfect is the best practice in this respect that almost any degree of refinement will be guaranteed. Progress in high-speed engineering was exemplified at Chicago, in part, by greatly improved design and workmanship, better means of lubrication, better balancing, and better control of speed.

"The display of steam-engines other than those made in the United States was so limited as to give but little idea of recent

European progress or practice; although we may in a general way be informed as to this, it would have been very satisfactory to have seen it better illustrated by exhibits.

"The Willans engine was an interesting example of comparatively recent date. Its special novelty is in its central valve for steam distribution, and the means for cushioning independently of the steam distribution in the cylinders. The central valve arrangement affords excellent means of getting rid of water in the cylinders, and the cushioning by means of the direct air cylinder results in smooth running without any effort at steam distribution to that end; something that I should think very likely to receive more attention in the future. This engine has what are usually believed to be the disadvantages of rather unusually short stroke, is single-acting, and has a throttling governor, and yet it is credited with remarkable economic performance. As to its performance under test, it may be remarked that with a properly adjusted load and constant steam pressure the objections to a throttling governor disappear. This engine is, I believe, used largely in England for electric lighting, the installation very commonly being such that of several engines only as many need be kept in operation as will be what is considered properly loaded, the governing being done by one engine. I am informed that they are manufactured strictly interchangeable in every detail; something that, so far as I know, cannot be said of any other engine. This does not necessarily make the engine better, but it must cheapen the cost of production.

"There was nothing, I should think, especially noticeable in the vertical German engine, except evidence of good design and workmanship. The use of the Rider cut-off valve never found especial favor in this country, which is not, however, said as in any way against it. Balancing the weight of the valves and connections by means of steam cylinders over them is not very new, at least; connecting the top of the balancing cylinders with, in the instance of the intermediate cylinder, the low-pressure steam-chest, and in the instance of the low-pressure cylinder, the condenser, while steam underneath the balancing pistons is taken from the respective steam-chests, may or may not be novel.

"The German portable and semi-portable engines were examples of elaborate construction beyond what we see in this country, but further than this, and the evidence of good general design, presented no very novel features.

"The French engine, by Schneider & Co., was mainly interesting as showing conclusive evidence of progress in the molder's art as applied to the making of castings for steam-engines.

"An evidence of the coming use of air cushioning was shown in the large Westinghouse engines by an air cylinder attachment to the high-pressure valve, which it would seem must assist the governor very materially.

"The most interesting example of progress in steam turbines appears to have been shown by the De Laval machine, in which a speed of as high as 30,000 revolutions is attained, the benefits of expansion being obtained by the use of a tapered nozzle, the smallest diameter being at the inlet. The commercial value of this machine may be doubted, but it is certainly, in its operation, a wonderful little engine.

"In direct-acting pumping engines notable progress since the Centennial was shown by the Worthington high-duty engine, with which you are all familiar. In direct-acting pumps of smaller size a good many have come into existence since that time, and as in steam-engines, compounding is fast gaining ground.

"Another noticeable feature is the growing popularity of independent condensing apparatus. Such apparatus has been in limited use for a long time, but it has been brought to its present state of perfection since the Centennial. Very fine adaptations were shown at Chicago, not less noticeable for their creditable operation than for compactness of arrangement and good general design.

"A great impulse was undoubtedly given to this branch of steam engineering by the advent of high speed, and recent progress, as illustrated at Chicago, has been very decided.

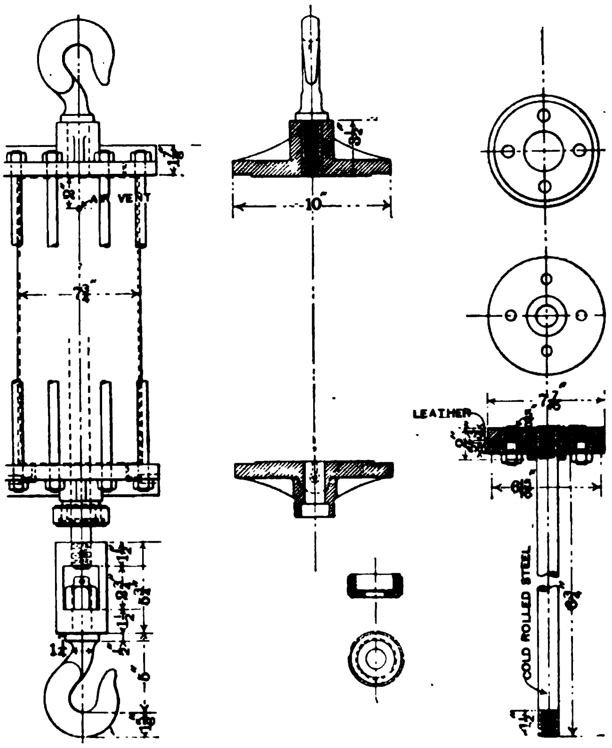
"An unfortunate feature of the engine exhibit was the numerous breakdowns and failures of some of the engines which were apparently in the experimental stage, something that was not to be expected at an exhibition of the character of this. It would seem to be a poor place to try experiments. Some failure is to be expected in the instance of a new departure in construction, and it is generally the case that some of the details must be changed or modified. But visitors generally conclude that this has already been attended to, as it ought to be, before public exhibition, and their criticism is, and justly, of what is and not of what might have been."

The paper was followed by an interesting discussion which lack of space prevents us from publishing.

PNEUMATIC HOIST IN THE SHOPS OF THE NEW YORK, NEW HAVEN & HARTFORD RAILROAD.

In our last issue we illustrated a pneumatic hoist which is in use in the shops of the Philadelphia & Reading Road, at Reading, Pa. These pneumatic hoists are becoming more and more common throughout the railroad shops of the country, and we know of one private shop in Ohio where the whole plant is thoroughly equipped with pneumatic arrangements for hoisting and conveying.

The New York, New Haven & Hartford shops, at New Haven, Conn., have quite a complete system of pneumatic arrangements for hoisting, and all of the large machine tools are provided with hoists. The plant consists of two Westinghouse pumps located in the engine-room, which supply the compressed air to a reservoir. The air is run under a pressure of about 75 to 80 lbs. to the square inch, and is led by pipes throughout the shops. Three sizes of hoists are used, two of which we illustrate in the accompanying engravings. These two are the largest and smallest that are used. The third one is intermediate between the two. It will be seen that in the larger hoist the cylinder is made of cast-iron heads bolted to flanges in the ordinary way. The hook beneath is held to a



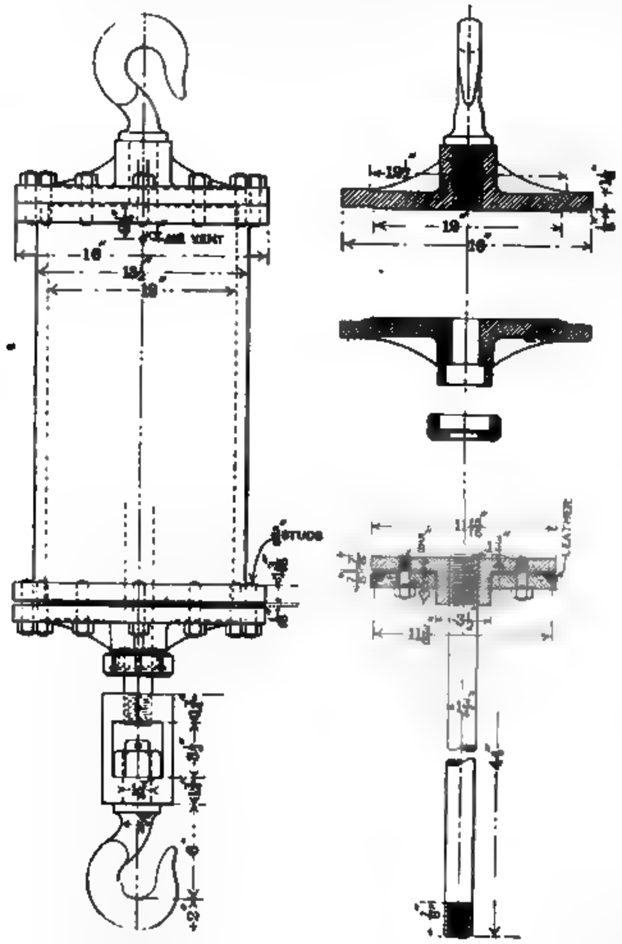
SMALL PNEUMATIC HOIST, N. Y., N. H. & H. R.R.

swivel chain, which is in turn screwed rigidly to the piston-rod. The general details of the piston and cylinder-heads are clearly shown on the engraving. The piston itself is a hub of cast iron with a leather cup packing bent down toward the piston-rod and held in position by a follower bolted up from the under side. This packing runs over a ring made of No. 8 spring wire, which allows an elasticity in the corner and serves to protect the leather from wear, as well as to give it a flexibility which is very desirable for this pneumatic work, where the pressure is apt to be suddenly applied, and unless there is a tendency to hold the latter out tightly there might be a detrimental leakage. The smaller of the two hoists, which is only 7¼ in. outside diameter, is made of a brass tube No. 8 stubs wire gauge. This tube is set into the cylinder-head at either end, which is in turn held together by eight ⅝-in. bolts, as shown on the engraving. These cylinders are hooked into a ring fastened rigidly into the overhead work of the shop, or else hung from trolleys which have a considerable movement and are supplied with air through a hose.

The largest size cylinder will readily pick up a pair of locomotive driving-wheels at the rate of, we should judge, 30 ft. a minute, which is rapid enough for any ordinary handling.

The length of the cylinders are made to suit the hoist which is required, but the larger size in the driving wheel shop are made 36 in. long, which gives a stroke of 33 in. In a future issue we trust to be able to publish a full and complete account of a pneumatic plant as applied to a large shop, showing all of the various apparatus that has been designed therefore.

The valves which are used on the New Haven Road are globe valves, admitting the air beneath the piston and exhausting into the atmosphere of the shops by the same means. The packing is tight enough, so that the weight can be held suspended safely without any danger of settling for an almost indefinite time. The uses of compressed air, as we have already said in describing the Norwalk air compressor in another column, is meeting with wider and wider application for shop uses and hoisting purposes, and is well worthy the investigation of those who are interested in the economical production of machine work.

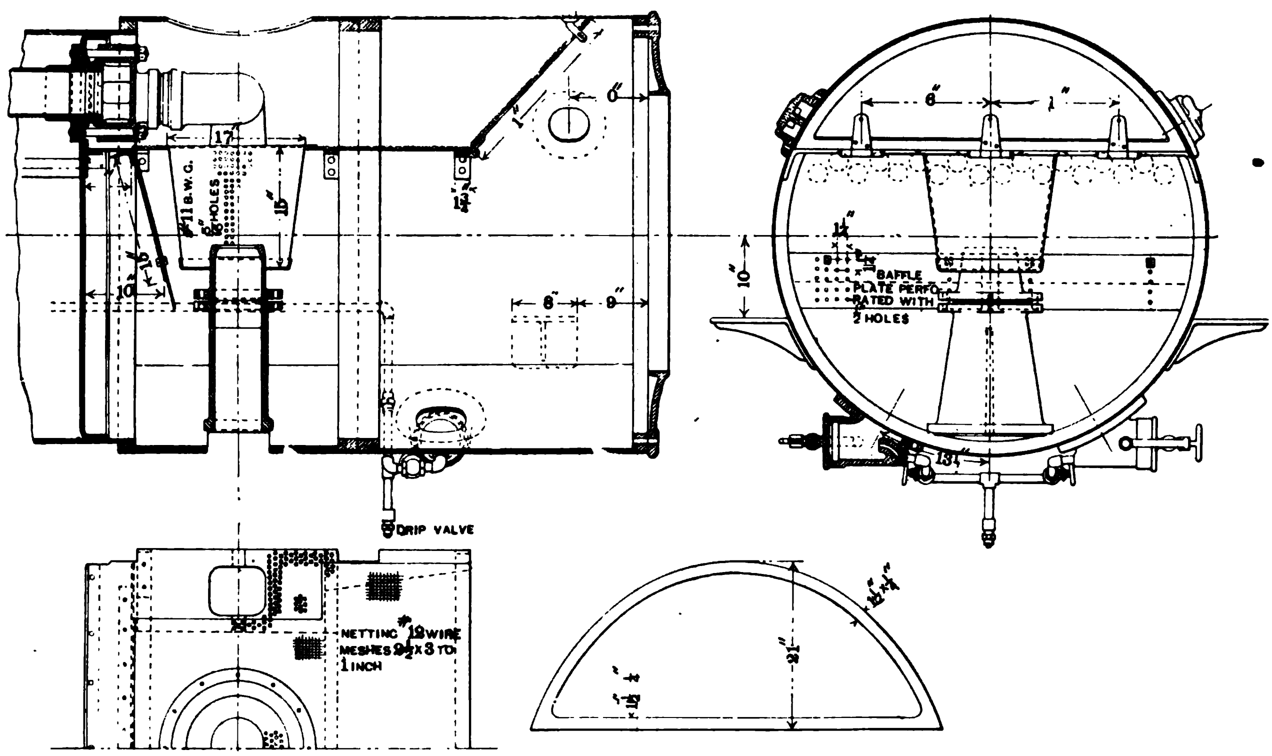


LARGE PNEUMATIC HOIST, N. Y., N. H. & H. R.R.

THE FIRST-CLASS BATTLESHIP "ROYAL OAK."

The *Royal Oak*, built by Messrs. Laird Brothers, of Birkenhead, is one of the largest battleships constructed for the British Navy, and was built under the Naval Defense Act. Her dimensions are: Length, 380 ft.; breadth, 75 ft.; mean draft, 27.6 ft.; displacement, 14,150 tons; freeboard forward, 19.6 ft.; aft, 18 ft.; indicated H.P. natural draft, 9,000; forced draft, 11,000; speed, natural, 16 knots: forced, 17½ knots; coal carried at the designed load draft, 900 tons; coal endurance at 10 knots, 5,000 knots; total weight of armament, 1,910 tons; height of heavy guns above water-line, 23 ft.; length of the belt or side armor, 250 ft.; greatest thickness, 18 in.; protective deck, 3 in.; total weight of armor, backing, and protective deck, about 4,500 tons. As befits her enormous bulk and weight, the construction of the ship has been made exceptionally strong. The hull alone absorbs over 9,500 tons of the total displacement. She is built entirely of mild steel, the stem and stern-posts and shaft brackets being formed of steel castings. The hull from end to end is largely subdivided, for the purpose of minimizing to the fullest possible extent the danger arising from damage to the bottom plating from rocks or torpedoes, and that this form of construction is effectual was exemplified when H.M.S. *Howe* went ashore at Ferrol. The framework has been specially designed with reference to the great weight to be carried, and additional stiffness is secured by double longitudinal bulkheads, which form a passage for easy communication below the water line from end to end, and within these are placed the auxiliary magazines. A protective steel deck, 2½ in. in thickness, extends under water from the bow for about 76 ft., and from the stern for a distance of about 72 ft. From this deck, and resting upon an armor shelf, is built a belt of steel-faced armor, with a backing of teak. The lower edge of the belt extends 5 ft. 6 in. below the load draft-line, while the upper edge is carried 3 ft. above the line. The greatest thickness is 18 in., the belt itself extending over a length of 250 ft., out of a total length of 380 ft., and terminating in armored bulkheads. At the fore and after ends of the belt, and rising directly from the protective deck, are the barbettes, strongly framed in mild steel, protected by teak backing and armor 17 in. thick. Superimposed upon the thick belt is placed another belt of light armor, 4 in. thick at the sides and 3 in. on the screens, running across the ship, and behind this side armor coal bunkers are arranged, whereby additional protection is secured. On the level of upper edge of the armor belt there is also a 3 in. steel deck, worked so that horizontal deck protection extends from end to end. The guns are protected by 6 in. screens, and the gun crews by armored emplacements, and in order to procure a safe passage for the ammunition from the several magazines to the guns of the secondary armament, armored tubes have been specially fitted. It is also to be noted that, with a view of preventing water from finding its way below the protective deck, means are provided for closing the several openings by water tight covers, while in the case of those which must necessarily remain open, coffer dams have been fitted with the same object. She is lighted throughout with an installation of over 630 electric lights, and equipped with four search lights of 25,000-candle power, each of which will be worked by dynamos under protection. The ship in action will be fought from either of two conning towers, of which the forward one is armored to the extent of 14 in., and the after one to 3 in. The port and starboard engine and boiler rooms are separated by middle-line longitudinal bulkheads extending the whole length, and there are also longitudinal bulkheads at the sides extending throughout the machinery space, forming coal bunkers and wing spaces. On the platform, *débris*, and lower decks is placed the auxiliary machinery for the working of the ship, including steering engines, electric engines, and hydraulic pumping engines, as well as a fully equipped workshop and numerous store-rooms. The officers and crew are placed on the main and belt decks. The officers' accommodation consists of very completely fitted cabins situated aft, the superior officers being located on the main deck. The admiral's suite of rooms, which are especially handsomely fitted, are at the extreme aft end of the main deck, and communicate with a handsome stern walk. The upper deck extends from stem to stern without a break, and above it is a continuous bridge-deck extending the whole length between the barbettes, and on this deck are the conning towers surmounted by the navigating bridge and chart house. The boats, of which there are 21, including two torpedo-boats, are stowed amidships. A strong steel derrick is fitted to the mainmast for lifting them, and the foremast is also fitted with a derrick for working those of a lighter description. The masts, which are built of steel, are fitted with military and signaling tops, and there are two funnels on the same athwartship lines. The armament of the *Royal Oak* will comprise four 13.5-in. 67-ton guns, mounted *en barbette* in pairs, and firing a projectile weighing 1,250 lbs., with a powder charge of 630 lbs.; ten 6-in. 100-pdr. quick-firing guns, the four on the main deck being mounted in casemates protected by 6-in. armor, while the six on the upper deck are mounted on sponsons; sixteen 6-pdr., and nine 3-pdr. quick firers; eight small machine guns; and two 9-pdr. field guns. The auxiliary armament is distributed all over the ship, and extends from bow to stern, the top, sides, and bridges having a considerable number disposed upon them. The main armament is worked by hydraulic machinery, supplied by Sir W. Armstrong, Mitchell & Co. The other guns are all worked by hand, the 6-in. by one man, the others being employed for feeding purposes. The ship is also fitted with seven torpedo tubes, of which two are submerged. The number of torpedoes carried is 18. The main propelling machinery consists of two sets of engines of the triple expansion inverted type. Each set is placed in a separate engine-room. The cylinders are 40 in., 59 in., and 88 in. in diameter respectively, with a stroke of 51 in.; they are entirely independent castings, and are bolted together by

brackets. The receivers consist of copper pipes attached to gun-metal branches, and expansion joint stuffing-boxes. The whole of the cylinders are steam jacketed, the working barrels of the high-pressure being of forged steel, and those of the low and intermediate-pressure cylinders of cast iron; the slide-valves for the high and intermediate pressure being of the piston type, whereas the low-pressure cylinders have flat double-ported valves. A special type of relief ring is fitted at the back of these flat valves. Balance cylinders are fitted to the high-pressure and intermediate valves, and assistant cylinders to the low, to reduce the strain on the valve-gear as far as possible. The valve-gear is of the double-eccentric link-motion type, and is moved by means of a double-cylinder starting engine. The columns are of wrought steel. The main condensers, which are of brass, have a collective cooling surface of 14,500 sq. ft. The steam is condensed outside the tubes, the circulating water passing through them. The water is supplied by four 18-in. Allen's centrifugal pumps, each driven by an independent engine. Suctions are also led to the bilges from these pumps, which give a total bilge pump power of 4,400 per hour. The crank-shaft for each set of engines is in three separate pieces, the cranks being set at 120° to one another. The crank, thrust, and propeller-shafts are all hollow, an 8-in. hole being bored through their entire length, and they are each forged from a solid steel ingot. The thrust-blocks and collars are of cast steel. The latter are lined with white metal, and are of the ordinary type. The screw propellers are four-bladed, the blades and bosses being of gun-metal. Steam is supplied by eight single-ended cylindrical return-tube boilers, working at 155 lbs. pressure per square inch, and being 15 ft. 4 in. in diameter and 9 ft. 4 in. long, each boiler having four corrugated furnaces 3 ft. 4 in. in diameter. The total grate surface is 710 sq. ft., and the total heating surface 20,174 sq. ft. For the purpose of shutting off each combustion chamber from the others, and also for regulating the draft in same, separate dampers are fitted in the passage from each through the smoke-boxes, and gear arranged to work the same conveniently from the stokehold floor. Following out the principle of subdivision, each two boilers are in a separate water-tight compartment, with independent coal supply, separate access to and from main deck, etc. The exhaust steam from the whole of the auxiliary machinery in the ship is led into an auxiliary exhaust pipe, which is connected both with the atmosphere by means of the auxiliary waste steam-pipes carried up outside the funnels, and with the two auxiliary condensers, one in either engine-room. Each of the latter condensers has its own air and circulating pump entirely independent of those for the main condensers, and worked by independent engines. The combined cooling surface of these two auxiliary condensers is 1,800 sq. ft. In the main engine-rooms there are also two double-cylinder turning engines, two evaporators with independent feed pumps, two distillers with circulating and distributing pumps, four No. 2 Admiralty type main feed pumps, of ample size to supply the whole of the boilers in full power, and four double-cylinder double-acting bilge and fire pumps of No. 1 Admiralty type. A pump for pumping out the drain tank, and two ventilating fans 6 ft. in diameter, each driven by a separate steam engine. In the boiler compartment there are eight fans 5 ft. 6 in. in diameter, each with its separate engine, for supplying the forced draft for the boilers, and also four double-cylinder double-acting auxiliary feed pumps of No. 2 Admiralty type. The weight of the anchors and chain cables is 130 tons, and if the cables were laid out in a single line they would extend about one mile. The total weight of metal work treated in the construction is upward of 9,000 tons, and the wages expenditure in Birkenhead represents considerably over £230,000, which is, of course, exclusive of labor in manufacture of armor plates, forgings, and a variety of fittings from sub-contractors.—*The Engineer.*



CROMWELL'S SMOKE-BOX.

CROMWELL'S SMOKE-BOX.

The engravings illustrate a form of smoke-box designed and patented by Mr. A. I. Cromwell, Superintendent of Motive Power of the Baltimore & Ohio Railroad, and which is in use on that line.

Immediately over the exhaust-pipe a "basket," as it is called, made of perforated metal plates, is placed. This is of the form of a frustrum of a cone, as shown. The open top of this is attached to horizontal wire netting, as shown, and encloses the top of the exhaust-pipe or exhaust-nozzle. The effect of the blast is to draw the products of combustion through the perforations in the basket. The smoke and flames are thus drawn through the tubes. In front of these openings, which lead into the smoke-box, an inclined deflecting plate is placed, which causes the currents to be deflected downward and toward the front of the smoke-box. They then turn upward and part of them pass through the openings in the basket and part pass through the netting. They thus momentarily, as it were, come to a state of rest, when the cinders fall and remain in the bottom of the forward end of the smoke-box, from which they may be removed by the spark ejector, shown very clearly in the front-end view.

This arrangement has been applied to a number of engines on the road referred to, and is working very satisfactorily.

THE RIVETING PRESSURES REQUIRED FOR BRIDGE AND BOILER WORK.

At a general discussion of this subject before the Engineers' Club of Philadelphia, Mr. Wilfred Lewis referred to a number of letters received expressing interest in the subject, and read a letter from Mr. David Townsend stating that he was prepared for the manufacture of rivets to be driven cold, a number of which were exhibited.

In regard to the pressure required for driving such rivets, Mr. Lewis recalled some experiments made by William Sellers & Co., Incorporated, between the compression platforms of their testing-machine. A number of ¾-in. rivets were subjected to pressures between 10,000 and 60,000 lbs. At 10,000 lbs. the rivet swelled and filled the hole without forming a head. At 20,000 lbs. the head was formed and the plates were slightly pinched. At 30,000 lbs. the rivet was well set. At 40,000 lbs. the metal in the plate surrounding the rivet began to stretch, and the stretching became more and more apparent as the pressure was increased to 50,000 and 60,000 lbs. From these experiments the conclusion might be drawn that the pressure required for cold riveting was about 300,000 lbs. per square inch of rivet section. In regard to the pressure for hot riveting, he said that until quite recently, within the last decade, there was never any call for a pressure exceeding 60,000 lbs., but that now pressures as high as 150,000 lbs. were not uncommon, and even 300,000 lbs. had been contemplated as desirable.

A letter from Mr. Henry G. Morse, President of the Edge Moor Bridge Works, was also read apropos of the discussion at the previous meeting on the strength of bolts as developed by long or short nuts.

Mr. F. H. Lewis: I have never seen a riveter of any kind that can always be relied upon to drive the rivets tight. Even those having pressures of 75 tons sometimes drive rivets that are loose, and this is probably due to the buckling of the plates.

Mr. Henry G. Morris: I have here an old sample which is intended to show that even the old toggle-joint riveter, if properly worked, will drive rivets that fill the holes even when they are badly matched.

Mr. Henry J. Hartley: This is a question which is occupying a great deal of attention at present among bridge and boiler men, and I know that some series of tests to get at the facts are now being carried on. The necessary pressure must, of course, be enough to upset the bolt and form a head upon it; but this will vary with the fitting of the holes, the temperature, and several other conditions. Books give little data on the subject, but I think the matter is of great importance, and would like to see it continued at another meeting, with the hope that more positive facts can be given. I, for one, will try to have something a little more definite. My personal opinion now is that machine-driven riveters do better work, and that the fault lies in the way that they are used, the riveter being generally run at one pressure, no matter what the diameter of the bolt and the thickness of the plates.

Mr. James Christie: I remember many years ago in the West they used to drive boiler-rivets cold, but afterward abandoned it on account of the deterioration in quality of the rivet iron.

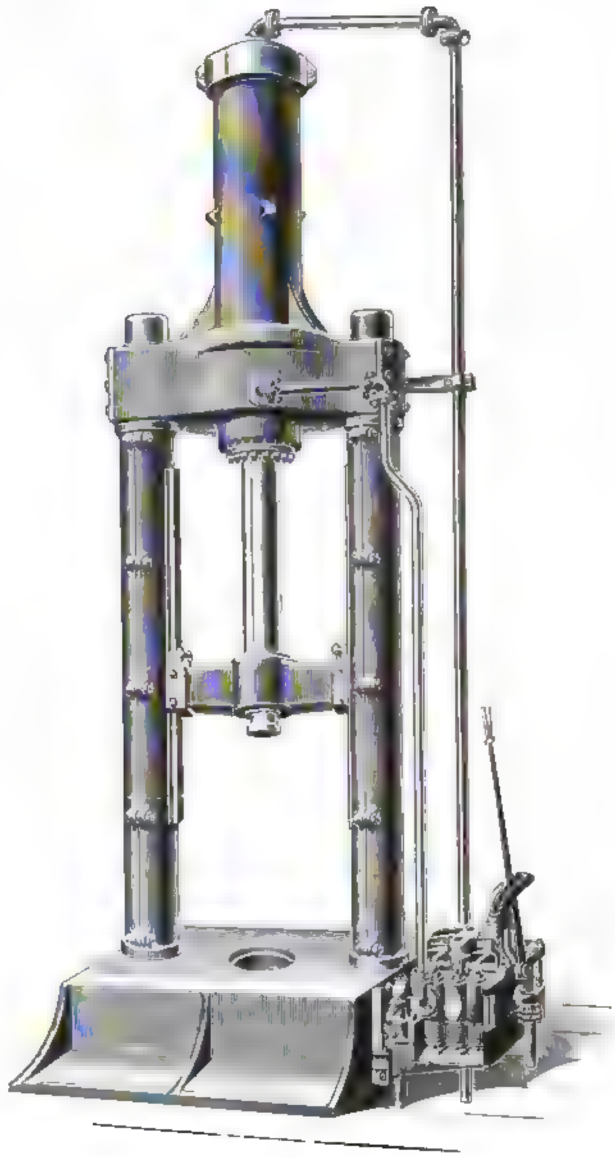
Since critical systems of inspection and testing material have become common, the importance of having rivets solidly driven has been more thoroughly appreciated than formerly. Hand work is avoided where possible, and higher pressures are used than before. Machines are preferred that will deliver the maximum pressure to the rivet with certainty. The direct hydraulic ram has the advantage of compactness, and when its fluid is stored in an accumulator there is a sudden impact or elevation of static pressure on the rivet at the termination of each stroke—a circumstance highly favorable to the riveting operation.

It has been found in girder work, that for red-hot rivets of iron or soft steel, with length of grip not exceeding three diameters, a pressure of 50 tons per square inch of rivet section has been sufficient to completely fill the hole. Longer rivets require higher pressure, and in extreme cases this pressure must be doubled to secure solidity. The shape of the head can be modified to a form favorable for the flow of metal into the body. The results of some experiments are submitted on the board, illustrating the advantage of high pressure on the riveted joint.

At a subsequent meeting Mr. Henrik V. Loss exhibited a number of indicator cards taken by him from a bridge riveter at the Pencoyd Bridge Works a couple of years ago, by using a common steam indicator in connection with a pressure producing cylinder. These showed great variation in pressures existing with rivets of one dimension, amounting to about 50 per cent. for ¾-in. rivets, and 25 per cent. for larger ones. Although it is almost useless to try to formulate definite rules for the power necessary to do the work, it will be seen that if the average be introduced in comparing the two sizes, this average pressure amounts to about 1,800 lbs. per square inch on a 10-in. cylinder, which, when subtracting the pullback, gives 65 tons for either ¾ or ⅞-in. rivets. Does this mean that a large rivet takes no more power than a smaller one?

It is a fact that in many cases of upsetting, a small rivet requires greater power than a large one, probably due to the rapid cooling effect of the surrounding cold dies upon the heated bar.

A greater pressure, however, is necessary for boiler work, and ¾ or ⅞-in. rivets with grips like those used in bridge work



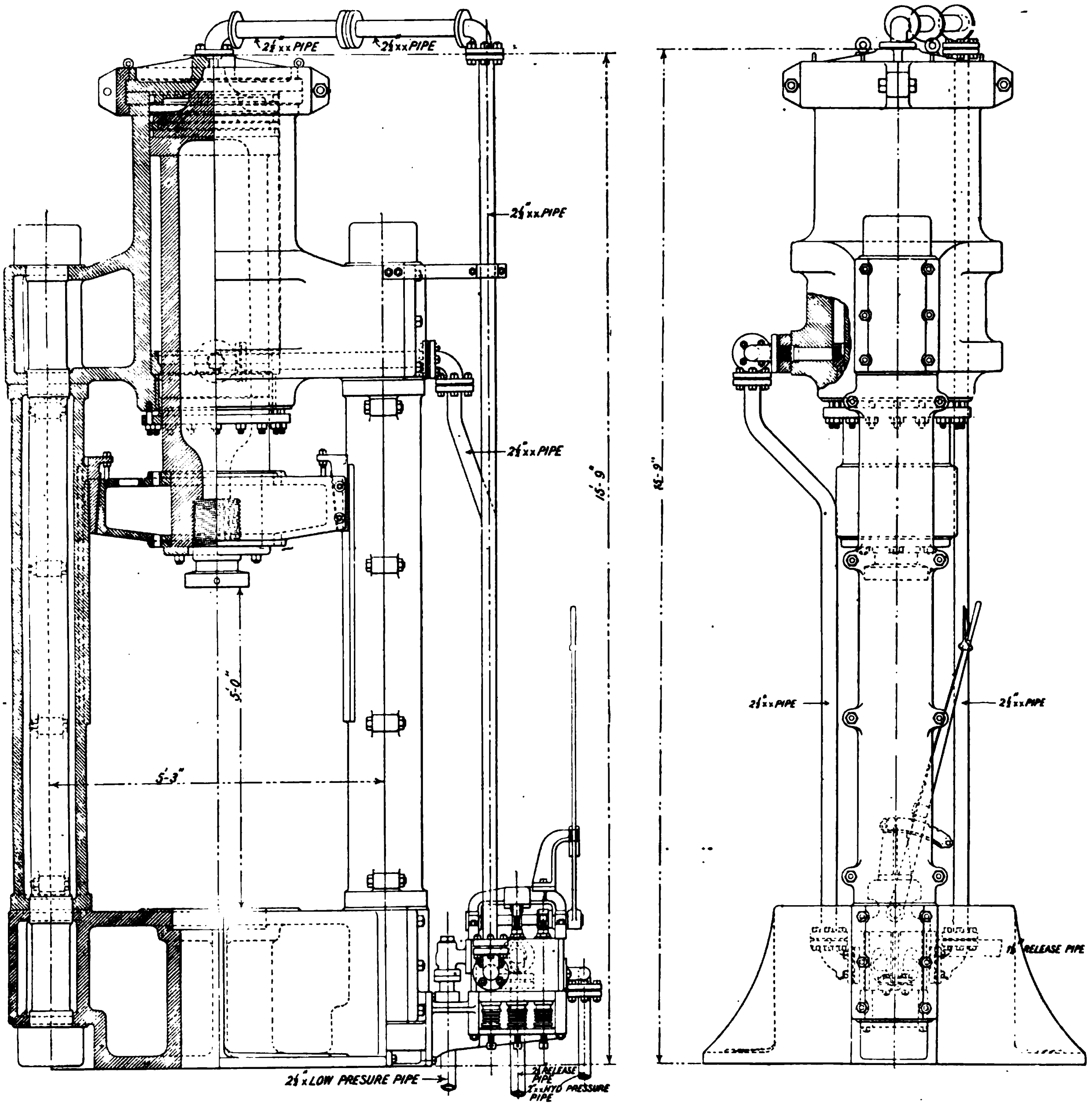
16-INCH PROJECTILE PRESS.

would require at least 75 to 80 tons, although for the smaller grips that usually prevail a pressure of 65 tons for the above dimensions would be sufficient. Upsetting a short rivet is a fair test of the strength of metal, for which definite rules can doubtless be laid down for the power required with reference to the diameter, but with long rivets this becomes almost impossible, as it can readily be supposed that for each length there is a corresponding diameter, which will give the smallest resistance per square inch of metal, a fact which was corroborated by the great irregularities in power lines of the cards shown that were taken from this class of work.

With regard to the energy consumed, a ¾-in. rivet needs about 7,200 foot-pounds, while a ⅞-in. rivet requires about 9,500 foot-pounds to form a head and fill the hole, if the work is about in the proportion of the squares of the diameters.

Whether this relation holds good for other dimensions will have to be determined by further experiment. It has been observed also that the energy in foot-pounds necessary to upset a rivet and the displacement of metal in the rivet due to the upsetting are in the same ratio.

Mr. James Christie: I have observed that the pressure required to upset small rivets is very much larger per unit of area and sometimes absolutely greater than for large rivets. It is very important to consider in this connection the character of the holes and the resulting resistance to flow of the metal. With 1¼-in. rivets, we have always found a pressure of 150 tons amply sufficient to make a tight joint and have the



SIDE AND FRONT ELEVATION OF 24-INCH GEAR PRESS, BUILT BY WATSON & STILLMAN.

rivets fill the holes. The latter is the main consideration, and to accomplish it it would seem that the higher the pressure the better, up to a point where the plates would be put under dangerous tension by the expansion of the rivet body.

Mr. S. M. Vauclain: A very important point to be considered is the condition of the rivet itself before being driven. It should be at exactly the right heat, and this is difficult to determine except by repeated trials. With iron rivets and poorly made holes we have found in boiler-work that it does not take very heavy pressures to fill the holes, provided the rivets have been properly heated. In one test that I made at the Baldwin Locomotive Works, I had six plates of ⅝-in. iron drilled with holes of diameters varying by ⅛ in. from ⅝ to 1⅛ in., and riveted with pressures varying from 25 to 100 tons. It was found that the best pressures to use for different sizes of rivets were as follows: For ⅝-in., 25 tons; for ¾-in., 33 tons; for ⅞-in., 50 tons; for 1-in., 66 tons; for 1⅛-in., 75 tons, and for 1¼-in., 100 tons.

We have found that the rivet to make a close joint should be hotter under the head than at the end, and if it is equally heated we cool the end by dipping it in water immediately before inserting it in the plates.

Mr. Jeffries (*visitor*): A series of exhaustive experiments were made at the Naval Dock Yards in England, which gave results almost identical with those described by Mr. Vauclain. Several years ago it was found that with thicknesses of ⅝ and ¾-in., plate closing was entirely unnecessary, but with 1-in. plates and thicker, it seems at least to be very desirable. The difference of opinion on this subject is probably due to the lack of uniformity in the method of operating the closing and riveting pressures successively. The closing pressure should be maintained for just the right length of time and then the pressure transferred to the rivet. A press to do this accurately has been designed, I believe, but is not yet used extensively in practice.

Mr. Wilfred Lewis: William Sellers & Co., Incorporated, have built a machine in which the pressure can be accurately managed by the operator, so as to be applied first to

closing and then transferred to the rivet. I have a letter from Mr. John T. Boyd, in which he speaks of hydraulic riveting as being preferable when it can be used, and recommends a plate closer when there is not absolute certainty of the riveting machine making tight work without it. He also favors an accumulator in which the weights can be dropped to vary the pressure applied to rivets on plates of varying thickness as opposed to one which furnishes uniform pressure for all kinds of work. He quoted excellent results obtained in riveting with pressures not exceeding 20,000 lbs. per square inch of area covered by the formed head of the rivet, but believed that the make of rivets and the thickness of plates should be taken into account to secure the most satisfactory results. A great degree of uniformity in heating rivets can be obtained with an oil or gas furnace.

Mr. James Christie: I may say that we have found in bridge work, in driving rivets of ¾ to 1 in diameter through thicknesses of 5 or 6 in., that it was best to use a plain bar and form a head on both ends at the same time.

Mr. John Birkinbine: From what has been said it would seem that the most important feature—namely, the quality of the iron in the rivets, is often neglected in its consideration; but in locomotive boiler and in bridge work, where many lives are dependent upon it, it would seem that nothing but the best quality obtainable should be considered as fit for use.

24-INCH GEAR PRESS, BUILT BY WATSON & STILLMAN.

Preserving Tools from Rust.—A good plan for preserving tools from rusting is the simple preparation employed by Professor Olmstead, of Yale College, for the preservation of scientific apparatus, and which he long ago published for the general good, declining to have it patented. It is made by the slow melting together of six or eight parts of lard to one of resin, stirring till cool. This remains semi-fluid, ready for use, the resin preventing rancidity and supplying an air-tight film. Rubbed on a bright surface ever so thinly it protects and preserves the polish effectually, and it can be wiped off nearly clean, if ever desired, as from a knife blade, or it may be thinned with coal oil or benzine.—*Royal Engineers' Journal.*

PROJECTILE AND GEAR PRESSES.

The United States Projectile Company, a portion of whose machinery is illustrated in another column, is engaged not only in the manufacture of rapid-fire, solid drawn projectiles of 4, 5, and 6 in. diameter for the United States Government, but also of gears and pinions for usage in certain places where the service is very severe. We illustrate herewith two presses which were made for them by Messrs. Watson & Stillmann, the hydraulic machinery manufacturers of New York.

The larger of the two presses shown has a cylinder 24 in. in diameter and 48 in. double-acting stroke, and the smaller have 10 in. and 16 in. rams of 48, 60, and 72 in. stroke. The larger is intended for gear work, and is used in forcing the blank of the gear through the dies from which it emerges compressed and finished.

The smaller presses, although less powerful, are doing the more interesting work. The heated projectile blank is placed beneath the ram and forced through dies which it leaves true in shape, straight, and ready for the trimming machine, which is illustrated in another column. The general construction of these presses is very clearly shown in the accompanying engravings. The upright cylinder is supported by two columns, one on either side, giving a free opening beneath for the handling of the material. The head of the ram has a cross-head with adjustable bearings guiding upon the upright. The end of the ram has a special shaped head for clamping the drawing tools to it. The accessibility of the packings is a prominent feature of the press design. The valve which is located upon the right of the press is in one of them beneath the level of the floor and is of peculiar construction, the valves being so balanced that they are readily operated and cause no trouble whatever.

The larger of the two presses is provided with a safety-valve on the top, so as to prevent excessive pressure. These machines are very powerful and occupy very much less floor space than those which were previously in use by the Projectile Company. The pressure of 2,500 lbs. to the square inch, which is used, gives upon the ram of 16 in. in diameter a pressure of 502,655 lbs., and on the 24-in. press the enormous pressure of 1,130,975 lbs.

In addition to the large accumulator carrying a heavy pressure there is one carrying a lower pressure of, say, from 100 to 125 lbs. to the square inch, and this is so arranged in connection with the valves that the plunger can be brought down to the work or to a point at which it begins to force the shell or the gear through the die. Thus this movement is accomplished without exhausting water which has been pumped into the accumulator under a pressure of 2,500 lbs. to the square inch, saving a considerable amount in foot-pounds of power. When the plant is operated in full force it is considered that this duplication and use of low-pressure system will effect a saving of more than 2 tons of coal per day.

The makers are not ready as yet to publish the details of this valve, but we hope in a future issue to be able to show the complete construction. It will be seen from the engravings that there are three valves held down by springs and operated by the lever moving through a quadrant on the side of the machine.

LOCOMOTIVE RETURNS FOR THE MONTH OF OCTOBER, 1893.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage. Passenger Trains.	Locomotive Mileage. Freight Trains.	Locomotive Mileage. Service and Switching.	Locomotive Mileage. Total.	Locomotive Mileage. Average per Engine.	Av. Train. Passenger Cars.	Av. Train. Freight Cars.	Coal Burned per Mile. Passenger Train Mile.	Coal Burned per Mile. Freight Train Mile.	Coal Burned per Mile. Service and Switching Mile.	Coal Burned per Mile. Train Mile, all Service.	Coal Burned per Mile. Passenger Car Mile.	Coal Burned per Mile. Freight Car Mile.	Cost per Locomotive Mile. Repairs.	Cost per Locomotive Mile. Fuel.	Cost per Locomotive Mile. Oil, Tallow and Waste.	Cost per Locomotive Mile. Other Accounts.	Cost per Locomotive Mile. Engineers and Firemen.	Cost per Locomotive Mile. Wiping, etc.	Cost per Locomotive Mile. Total.	Cost per Car Mile. Passenger.	Cost per Car Mile. Freight.	Cost of Coal per Ton.
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Atchison, Topeka & Santa Fé	822	744	...	...	...	2,278,337	3,056	...	...	...	...	...	82.67	...	...	3.93	7.42	0.20	0.14	6.77	1.23	19.60	...	...	1.71
Canadian Pacific	615	...	534,665	878,362	503,634	1,916,661	3,116	...	...	...	...	...	71.65	...	...	3.39	11.53	0.32	...	5.76	1.25	22.25	...	...	3.18
Chic., Burlington & Quincy	541	...	...	...	...	1,767,058	3,266	...	...	...	...	...	86.84	...	...	3.53	5.79	0.20	0.15	6.47	0.05	16.19	...	...	1.84
Chic., Milwaukee & St. Paul	856	...	...	...	...	2,875,011	3,358	6.75	19.33	...	...	...	68.38	...	...	3.52	7.81	0.27	...	6.66	...	18.26	...	...	2.38
Chic., Rock Island & Pacific	564	...	601,128	1,152,073	367,880	2,121,081	3,761	...	...	66.66	81.07	41.52	70.67	...	...	2.74	6.76	0.24	2.74	6.11	0.83	18.92	...	...	3.04
Chicago & Northwestern	1010	...	907,808	1,578,767	690,665	3,177,240	3,146	...	...	...	...	...	88.92	...	...	2.98	7.94	0.30	...	6.32	0.72	18.26	...	...	1.76
Cincinnati Southern	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cumberland & Penn.*	23	23	6,509	35,119	...	41,628	1,809	...	...	...	...	...	81.11	...	...	7.83	4.40	0.86	...	...	1.78	14.88	...	...	...
Delaware, Lackawanna & W. Main L.	211	194	72,565	196,825	434,399	705,789	3,638	...	...	...	...	...	89.12	...	...	2.57	6.81	0.48	...	5.96	...	15.77	...	...	1.60
Morris & Essex Division	162	...	183,053	152,079	102,352	436,484	3,064	...	...	...	...	...	60.79	...	...	3.64	9.52	0.43	...	6.47	...	20.06	...	...	3.10
Hannibal & St. Joseph	72	72	...	...	...	284,512	4,007	5.90	16.54	...	...	...	84.85	12.51	6.69	2.28	7.16	0.14	0.40	6.59	0.01	16.55	...	...	1.76
Kansas City, F. S. & Memphis	152	...	94,505	229,945	91,981	416,431	2,776	...	...	...	...	...	64.83	...	...	3.34	5.44	0.33	0.35	7.31	...	16.77	...	...	1.63
Kan. City, Mem. & Birm.	42	40	33,977	57,802	12,092	103,871	2,597	...	...	...	...	...	62.77	...	...	2.69	3.50	0.22	0.32	6.96	...	13.69	...	...	1.06
Kan. City, St. Jo. & Council Bluffs	38	38	...	...	...	134,016	3,527	5.53	22.37	...	...	...	71.04	13.82	4.71	3.82	6.45	0.15	0.49	6.30	0.04	17.25	...	...	1.88
Lake Shore & Mich. Southern	593	...	543,724	816,026	436,455	1,796,205	3,382	...	...	72.67	88.88	38.72	71.71	...	...	1.98	5.62	0.12	0.06	6.87	0.15	14.75	...	...	1.57
Louisville & Nashville	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Manhattan Elevated	...	293	760,238	...	67,332	827,570	...	...	...	...	...	...	40.48	...	...	2.20	8.00	0.20	...	9.20	...	19.60	...	...	3.94
Mexican Central	148	115	...	...	...	876,868	3,277	...	...	...	...	...	67.82	...	...	5.88	13.55	0.35	0.20	4.72	0.74	24.94	...	...	4.40
Minn., St. Paul & Sault Ste. Marie	...	...	86,129	153,602	64,725	304,456	...	4.99	21.01	...	...	...	51.19	...	...	3.30	12.66	0.22	...	6.44	...	22.62	...	...	3.70
Missouri Pacific	336	...	...	...	...	1,026,406	3,579	4.40	16.69	...	...	...	84.17	...	...	3.07	6.02	0.33	1.12	6.27	1.30	18.11	3.59	1.30	1.89
Mobile & Ohio	107	80	76,661	139,773	56,381	272,810	3,410	...	...	...	...	...	62.56	...	...	2.04	4.53	0.22	0.64	5.75	0.89	14.07	...	...	1.43
N. O. and Northeastern	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
N. Y., Lake Erie & Western	639	434	488,365	855,402	259,486	1,603,253	3,781	5.40	24.30	92.10	139.80	79.25	108.71	17.20	5.80	4.01	7.81	0.38	2.54	7.46	1.14	23.84	...	...	1.38
N. Y., Pennsylvania & Ohio	267	182	215,805	368,449	129,510	713,755	...	6.40	18.60	75.90	132.80	91.55	99.90	...	...	3.92	5.87	0.81	2.05	7.13	0.95	20.23	...	...	1.12
Norfolk & Western, Gen. East. Div.†	...	...	93,213	300,595	42,185	445,993	2,655	5.70	20.90	56.20	127.20	...	91.70	9.80	6.10	3.91	4.02	0.29	...	...	...	8.22	...	...	3.00
General Western Division†	...	...	110,807	309,335	46,339	466,481	2,667	5.70	17.30	...	...	...	125.00	13.66	8.20	4.92	4.61	0.28	...	...	...	9.81	0.77	1.83	...
Ohio and Mississippi	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Old Colony Div. N. Y., N. H. & H.	...	...	530,201	190,675	245,617	967,573	...	3.80	16.70	...	...	7	78.30	16.80	4.70	2.60	9.21	0.68	...	6.91	0.90	20.25	...	...	...
Philadelphia & Reading*	...	...	466,207	328,725	1,046,464	1,841,396	...	...	...	...	...	...	73.12	...	...	4.95	4.70	0.37	...	5.83	0.40	16.95	...	...	...
Southern Pacific, Pacific System	741	669	644,655	1,042,908	281,149	1,968,712	2,943	5.58	14.04	...	...	...	70.42	...	...	3.91	17.18	0.22	1.95	7.38	1.02	31.66	...	...	4.58
Union Pacific	1024	863	562,432	1,359,903	301,430	2,223,765	3,712	...	...	...	...	...	86.43	...	...	6.56	8.30	0.40	...	7.90	1.01	24.17	...	...	1.92
Wabash	425	353	502,479	611,439	236,380	1,340,298	3,797	5.73	17.78	78.15	107.06	53.85	88.18	18.68	6.02	3.46	5.01	0.32	...	6.13	0.86	15.78	2.10	1.04	1.16
Wisconsin Central	149	114	124,498	192,190	599,060	876,648	3,305	...	...	...	...	...	81.49	...	...	3.02	9.61	0.20	...	6.61	...	19.44	...	...	2.84

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars. Empty cars which are reckoned as one loaded car are not given upon all of the official reports, from which the above table is compiled. The Union and the Southern Pacific rate two empties as one loaded; the Kansas City, St. Joseph & Council Bluffs and Hannibal & St. Joseph Railroads rate three empties as two loaded; and the Missouri Pacific and the Wabash Railroads rate five empties as three loaded, so the average may be taken as practically two empties to one loaded.

* Switching engines allowed 6 miles per hour; wood, construction and gravel trains, 10 miles per hour.

† Wages of engineers and firemen not included in cost.

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

The object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publication will in time indicate some of the causes of accidents of this kind, and help to lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with information which will help to make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we all intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in December, has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS IN DECEMBER.

Columbia, Pa., December 2.—Mart M. Hinkle, an engineer on the Pennsylvania Railroad, received a painful injury today. He had raised the lid of the tank-box when the wind blew it down on his right hand, bruising it badly. No bones were broken.

Philadelphia, Pa., December 2.—A misplaced switch caused a wreck at the Broad Street Station of the Pennsylvania Railroad this evening. A train from the Schuylkill Division crashed into a number of empty cars which were about to be made up on the main line. Fireman Charles F. Bright jumped from the train when he saw the collision was inevitable, and was slightly cut about the head. The engineer stuck to his post and escaped injury.

Camden, N. J., December 2.—Engineer William Tucker was carried by a runaway engine on the Reading Railroad at the foot of Linden Street into the Delaware River. Tucker managed to crawl out of the cab-door before he became unconscious, and was then helped ashore.

Fort Worth, Tex., December 4.—A locomotive on the Texas Pacific exploded its boiler shortly after noon to-day about a mile west of Eastland. The engine was running about 18 miles an hour at the time. Charles F. Elliott, engineer, and Jesse Beaver, fireman, were instantly killed, the bodies being thrown 100 ft. from the point of the explosion.

Welch, W. Va., December 6.—A freight train on the Norfolk & Western Railroad broke in two when coming through the Flat Top tunnel this morning. The engineer started ahead with the front end to prevent a collision. When passing Cold Dale Station they were running at the rate of 40 miles an hour. On a stiff down grade 500 yds. east of Mayberry, the engine jumped the track between two trestles, upset, and killed Engineer Stocker and Fireman Hain. The two men were killed almost instantly, and their bodies rendered almost unrecognizable by the escaping steam, which scalded them and drove the dirt under their skin.

South Norwalk, Conn., December 6.—An engine and five cars of the Pittsfield freight, bound north on the Danbury & Berkshire Division of the Consolidated Road, ran off an open switch at Bethel late this evening and were wrecked. It is claimed that the switch was thrown by the running away of a horse. The engineer was slightly injured.

Gardner, Mass., December 7.—The boiler of a freight engine on the Fitchburg Railroad exploded at Baldwinville this afternoon. Engineer Otis was slightly scalded, and Fireman Wight was blown from the engine across two tracks, a distance of 30 ft. He was slightly injured on the back.

Pittsburgh, Pa., December 9.—Barney Burke, an engineer on the Fort Wayne Road, was seriously injured this morning by being caught between cars.

Fort Worth, Tex., December 9.—An engine was derailed in the Fort Wayne & Denver yards this afternoon by a misplaced switch. The engineer and fireman succeeded in jumping, the engineer being slightly injured about the leg.

Denison, Tex., December 11.—E. A. Mather, fireman on the Fort Wayne & Denver Road, was struck by bridge timbers while looking out of the cab window this afternoon. He was unconscious when taken from his seat, and remained so until he died.

Terre Haute, Ind., December 11.—Engineer Michael Barry jumped from an engine on the Vandalia mail train this afternoon. A switching engine had backed on to the main track just ahead of him, and he thought a collision was inevitable. After reversing the engine and throwing on the air-brakes he jumped and was knocked insensible by the fall.

Littleton, N. H., December 12.—A mail train on the Concord & Montreal Railroad was thrown from the track between Fabyans and Wing Road this morning. Andrew G. Pike, engineer, was injured internally, and it is feared fatally. Fireman Miller was scalded, but not seriously.

Allentown, Pa., December 13.—A Lehigh Valley engine crashed into a freight at Chain Dam this morning. The collision was due to the negligence of a brakeman in not signalling the locomotive, the engineer of which was a new man. Fireman Keiper was slightly injured.

Wilkesbarre, Pa., December 13.—A passenger train on the Pennsylvania Road ran into a switch engine near Nanticoke this morning. Engineer Newton Frace had his leg badly bruised. M. McDermott, the fireman, had his wrist sprained.

Lancaster, Pa., December 13.—A collision occurred on the Pennsylvania Road through the breaking in two of a freight train, in which Engineer Lilley was thrown against the side of the car, in which he was at the time, and his left side and face badly bruised.

Lucas, O., December 14.—A passenger train on the Pittsburgh, Fort Wayne & Chicago Railroad ran into the rear end of a freight train near this point to-day. Fireman Martin was badly hurt.

Dunkirk, N. Y., December 15.—A Western New York & Pennsylvania passenger train crashed through a 20-ft trestle into a creek near Herrick's Roads this evening. Benjamin McLane, engineer of the train, had his ankle sprained.

Harrisburg, Pa., December 15.—Frank B. Weaver, a Pennsylvania Railroad fireman, was seriously injured at Parksburg to night. He had temporarily changed places with the front brakeman, and while applying a brake the chain broke. He was thrown from the car by the whirling of the brake. He had three terrible gashes on his head and a fourth wound above the right eye. His back was also severely hurt.

Terre Haute, Ind., December 16.—Two freight trains collided on the switch tracks of the Big Four Railroad at Grant Station to-night. The engineers and firemen jumped and escaped with slight injuries.

Louisville, Ky., December 17.—A section of the freight train on the Chesapeake & Ohio on the Southwestern Railroad was wrecked this morning. The engine and four loaded flat cars were thrown down a steep embankment. Thomas Keegan, engineer, and Jack Downs, the fireman, were killed.

Indianapolis, Ind., December 18.—An extra freight on the Indiana & Vincennes Road ran through an open switch near Centerton, 20 miles west of this city, this evening. The switch had been left open. The engineer and fireman jumped and escaped with slight bruises.

Milwaukee, Wis., December 18—A switch engine on the Chicago, Milwaukee & St. Paul Road ran into two sleeping-cars this evening. Engineer W. W. Cunningham was slightly injured.

Augusta, Ga., December 21.—A fast passenger train on the Richmond & Danville Railroad ran into a local freight train on a siding at Graniteville to-day. The engineer, Ficklin, and Fireman York were thrown through the cab window, Ficklin being horribly scalded by escaping steam. Engineer Hughes and Fireman Allen of the freight leaped through the cab before the collision.

New York, N. Y., December 22.—Henry Stanford, a fireman on the New York Central Railroad, while walking along the top of the train was knocked off by a low bridge at One Hundred and Sixty-fourth Street. He was picked up bruised and unconscious, his skull having been fractured.

Philadelphia, Pa., December 22.—A collision occurred on the Philadelphia & Baltimore Central Railroad at South Street Station this evening. An east-bound passenger engine ran into a large coal car. Engineer Ed. H. Brown and Fireman Larry Doran were badly bruised.

Coatesville, Pa., December 25.—A collision occurred between two engines on the Pennsylvania Railroad this morning. John Michael, an engineer on one of them, was seriously injured.

Ashland, Wis., December 26.—A freight train on the Duluth, South Shore & Atlantic Railroad was derailed near Trout Creek to-day, and the engine and six cars went down an embankment 30 ft. high. Engineer Mulford died a few minutes after being taken from the wreck.

Roanoke, Va., December 27.—A vestibuled train on the Norfolk & Western Railroad ran into an open switch at Troutville yesterday morning. It collided with a freight train. J. L. Olney, engineer of the passenger train, and Fireman J. C. Childress were severely hurt by jumping.

San Antonio, Tex., December 28.—A bolt driven into the point of a split switch at McDonough on the Southern Pacific

Railroad this evening caused an east-bound freight train to leave the track. The engine turned over on Engineer Taylor and Fireman Turner. Turner's legs were crushed and he will die. Taylor was badly bruised.

St. Paul, Minn., December 30.—A train on the Northern Pacific Railroad ran into a deep snowbank between Boulder and Elkhorn to-day, the engine and tender being jack-knifed. Engineer Dennis G. Delay had both legs amputated below the knees. Fireman John Regan was crushed about the left leg and spine.

Springfield, O., December 30.—A collision occurred between a local passenger train at Quincy, O., on the Ohio Southern Road, to-night. Ed. Jackson, engineer, and Thaddeus Jones, fireman, were killed

Our report for December, it will be seen, includes 31 accidents, in which six engineers and six firemen were killed, and 20 engineers and 15 firemen were injured. The causes of the accidents may be classified as follows:

Boiler explosions	2
Breaking through trestle	1
Caught between cars	1
Collisions	11
Derailments	4
Falling of tool-box lid	1
Jumping from engine	1
Misplaced switches	4
Runaway engines	2
Running into snowbank	1
Struck by obstruction	2
Thrown from train	1
	31

DETENTIONS TO TRAINS FROM FAILURES OF PASSENGER LOCOMOTIVES.

We are able to give herewith a tabular statement of locomotive failures on another prominent road in which the data is given in a somewhat different form from those heretofore published in these pages. The table will repay study and discussion, and criticism is invited.

STATEMENT OF PASSENGER TRAINS FOR NOVEMBER, 1893, AND FAILURES OF PASSENGER ENGINES IN SAME SERVICE ON DIVISIONS G, H, AND I.

Cause.	G.		H.		I.		Total No.	Total Time Lost.
	No.	Time	No.	Time.	No.	Time.		
		Min.		Min.		H. M.		H. M.
Air-hose bursting	...	...	1	19	2	22	3	41
Air-pump giving out	...		2	45	1	....	3	45
Air-drum whistle	....	....	1	30	...	....	1	30
Ash-pan	....	....	....	. ..	1	5	1	5
Brake disconnected	....	....	1	3	...	....	1	3
Cylinder bridge	..	...	1	30	....	....	1	30
" head	2	18		...	1	39	3	57
Crank-pin hot	....	...	1	5	2	45	3	50
Driving-box hot	2	25	2	43	13	2 20	17	3 28
Engine-truck hot	...	....	....	...	2	...	..	....
Exhaust nozzle	....	....	1	20	....	....	1	20
Follower bolts	1	10	....	....	....	....	1	10
Flues leaking	....	....	1	3	2	34	3	37
Fire-box staybolts	..	....	1	25	....	....	1	25
Injectors	....	..	2	29	1	5	3	34
Injector hose uncoupling	...	....	1	6	....	....	1	6
Lubricator glass	...	....	....	....	2	20	2	20
Main rod strap	1	18	...	....	....	....	1	18
" " key	...	....	1	12	....	...	1	12
Packing ring	1	7	...	....	....	....	1	7
Piston-rod	..	....	..	....	1	40	1	40
" gland	...	. ..	1	5	....	....	1	5
Rocker arm	1	18	....	....	....	....	1	18
Side rod broken	....	....	....	....	1	....	1	....
Spider	1	69	...	....	1	....	2	69
Spring hanger	....	....	1	45	....	...	1	45
Tender-box hot	2	12	3	65	7	85	12	2 42
Valve seat	1	....	...	...	....	....	1	....
Water scoop	....	....	3	15	1	....	4	15

Division.	Total No. Trains.	Total No. Miles.	Total No. Failures.	Total Time Lost.
				H. M.
G	2,349	95,283	12	2 57
H	3,272	250,111	24	5 40
I	2,449	182,199	36	7 51

METAL UNDERFRAMES FOR FREIGHT CARS.*

By G. R. Joughins.

The paper which I have the honor of reading before you to-night is one giving a short history of the experience which the Norfolk & Southern Railroad Company has had with some iron tubular cars, and also describing an experimental steel car designed and built at their works. It was with a great deal of hesitation we made a request to take up the time of this club, but it was with the hope that we could make a contribution of some value, however slight, on the subject of steel freight cars, a subject which, we believe, will soon assume an important place in the railroad economy of this country.

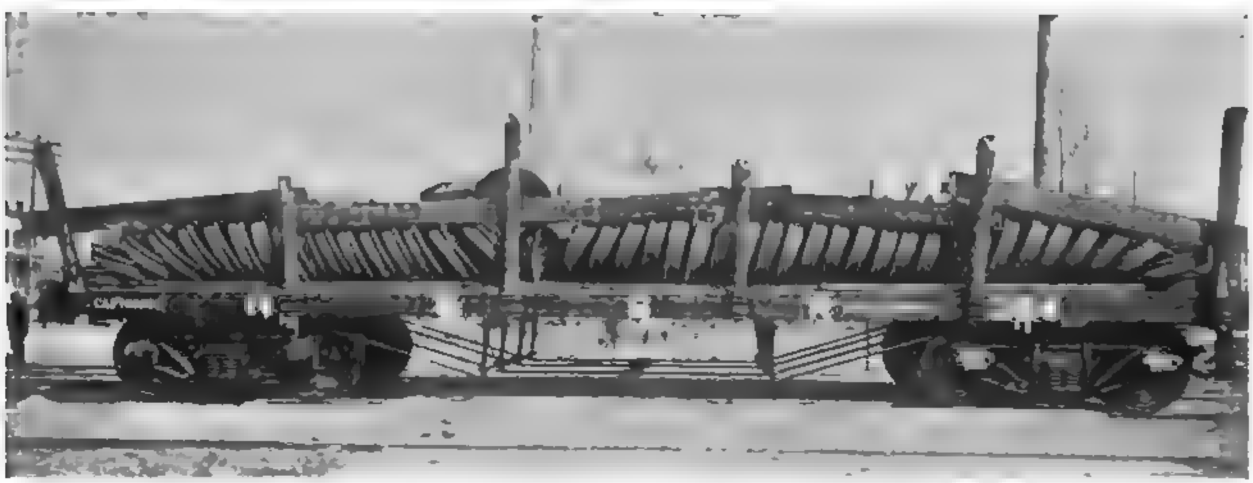
The railroad with which I am connected was opened in 1881. It runs from Norfolk, Va., along the sea-coast for some distance south, through a country which is intersected by wide rivers, bays and sounds, and in which the air is very heavily charged with moisture. A very few years after the road was constructed it was found that all timber, of whatever kind or quality, which had been placed in exposed positions, either in the track, on rolling-stock or steamboats, was decaying very rapidly. As soon as the fact that the climate was so peculiarly destructive to timber was observed by the officials, they became anxious to avoid the use of material which so quickly deteriorates; and, in connection with the rolling-stock, the Iron Car Company's cars were brought to the notice of the General Manager. The result was that in August, 1888, we leased from that company 50 of their flat cars for a period of five years, hoping by actual experience to determine what benefits might be secured from the use of iron frames instead of wood. Many members of this club are more or less familiar with the cars of which I speak, and have had more or less repairs to do upon them; I think, however, that very few have had the time or opportunity to look at this car in detail, to have it every day within their sight, or to see it under the most favorable circumstances; and are therefore not sufficiently familiar with it to be aware of its good features and to know exactly what its deficiencies really are. I have been looking at these cars nearly every day for the last three and a half years, and feel compelled to say that it is very seldom indeed I have come across a structure in which the details are so well designed as the details of these cars. It appears to me that the draftman was an artist in metal, he showed a profound knowledge of the art of designing malleable iron castings; every detail of the car has been formed on the most correct theory by some one who possesses an artistic eye competent to combine beauty and strength, and who instinctively cut away every ounce of superfluous metal. I feel that I cannot too much admire the cunning of the hand which molded these different details, and adapted them so perfectly to the strains which they are called upon to withstand. (I have here some examples of these details which will, I believe, bear criticism and prove my praise to be deserving.) Another excellent and very important feature of these cars is the method adopted for attaching the various parts together: everything is held in place by bolts and screws, and after five years' service I cannot find a piece loose, nor is there a single hole which is visibly worn out of shape; a gratifying and successful result which would have been impossible to obtain if rivets had been used to join any parts whatever. When I speak in this favorable strain of the tubular iron cars, I am sure that some of the members will be unable to understand why I should bestow a word of praise upon them—that is, because they have not had the opportunity to distinguish between their design in detail and their design as a whole. I understand that very few railroads can find a good word to say in their behalf, and that they must prefer seeing them on their neighbor's track instead of on their own. This is because the car possesses some defects in general design which are fatal to its successful use under the heavy handling which cars receive on railroads at the present day. I believe it was able to stand the shocks received by cars a few years ago, before the era of heavy motive power and improved draft-rigging, and before the yardmen found out how much more the improved appliances would stand without visible breakage. These weaknesses mostly arise from a very radical departure from previous practice, which the original designer or inventor of this car saw fit to make, by reducing the number of the sills, and by introducing new and untried attachments for the draft-gear. The car was also, I believe, designed to catch a wave of popularity. It was something which could be talked about in a fascinating way, as the tubes of which it is constructed represents to the mind of the uneducated engineer the greatest possible com-

* Paper read January 18 before the New York Railroad Club.

bination of strength and lightness, a fallacy which is a very popular article of belief among laymen. You are probably aware that the sills are constructed of eight tubes placed to form four sills, and designed to carry 80,000 lbs., but they are altogether too weak to support such a load, and when the car is loaded uniformly to its full capacity, the sills assume a sinuous or curved line which immediately show their inherent weakness; and when the car is loaded heavily at a point about midway between the supports of the sills, then they are certain to bend badly, and show far more deflection than wooden sills under a similar load. Another great mistake (the greatest mistake of all) was made by using four sills instead of the six, which we are accustomed to use in cars made of timber. It was evidently done to enable the builder to produce a car which would be light compared to the load which it was intended to carry. It was, however, a very grave error to lower its strength so much as to imperil its future for the sake of a few pounds in weight; the absence of centre sills necessitated some new design of draft rigging, and the unusual step was taken of constructing it so that all the pulling strains were taken directly on the end sills, and all the buffing strains on the body bolster, parts which were not made strong enough to withstand the heavy service on large roads and which consequently are nearly always in a state of collapse. There is also a peculiar arrangement of tail bolt and cotter which gives a great deal of trouble. This draft-gear and the means of fastening it to the cars form the most fatal objection to their use, they are the parts which first give out under the heavy strains, and they are a constant source of annoyance on our large railroads, at least where heavy cars and big engines are used. In every-day service it was therefore soon found out that the car was deficient in strength in the places named, and that when they failed, much difficulty, trouble, and annoyance were entailed in repairing them. It was also found that the parts required for repairs were special to this car, had to be obtained from the manufacturers, and were difficult and tedious to procure, so that a damaged car often took up room in the repair yard of a foreign road for several weeks, producing irritation in the minds of the officials, and giving another serious cause of complaint against the iron cars.

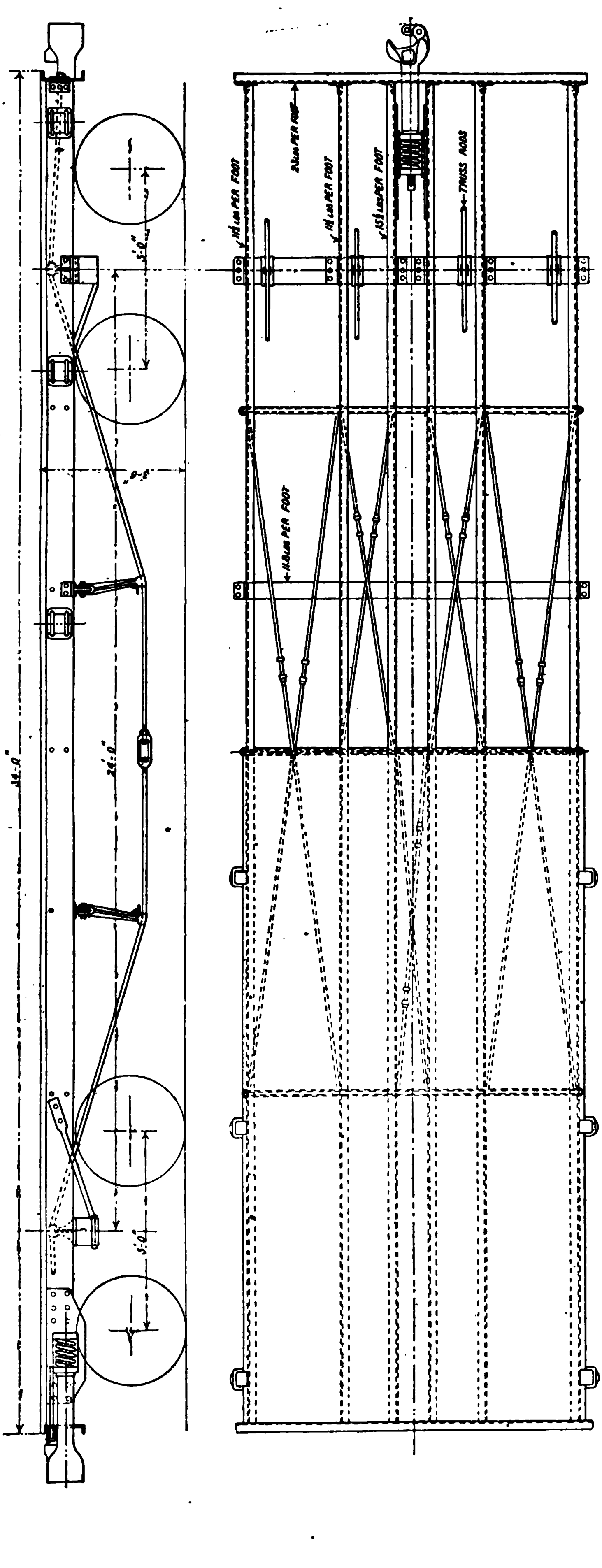
In the *Railroad Gazette* of May 26, 1893, there is an editorial headed "A Suggested Economy in Freight-Car Repairs," in which the writer calls attention to the heavy damages sustained by cars in the yards, and forcibly expresses his opinion that they are unnecessary and could be saved by judicious control. How far the idea upon which it is written could be carried out on our larger roads I do not know. Our railway is a small one, not overcrowded with trains, and we are therefore able to carry out the policy indicated. We have done so for years, every case of damage to cars is investigated, and if caused by the carelessness or stupidity of any employé some punishment is awarded; while, as an incentive to care for the company's property, and to take a personal interest in its protection, quarterly premiums are awarded to the train hands giving the most satisfactory service. The consequence of this watchfulness on the part of the management, combined with the influence of local conditions, has been very propitious to the iron tubular car, it has been operated under the most favorable circumstances, with the result that we are, I believe, the only railway which has made a success of it, and we have made it a great success. We are very much gratified with its performance, and are well assured that we have obtained large reductions in cost of maintenance compared with the cost of cars having timber frames.

With the experience obtained in the use of these cars, and by acting upon the suggestions of others in relation to metal frames, we have designed and built a sample steel car which, we think, is very much superior to the iron car of which I have just been speaking. We believe that we have built a car in which all the weaknesses of the tubular frame are obliterated, and against which very few of the objections raised against the iron car can be urged; indeed, we feel sure that it is strong enough to withstand the strains to which it may be subjected on any of our railroads, and that it can be maintained in good repair for an indefinite period with an exceedingly small annual expenditure. The experimental car which we constructed, and the design of which I have the honor of placing before you to-night, has six longitudinal sills made of 8-in. steel channel beams, the side and intermediate sills weigh 11¼ lbs. and the center sills 15¼ lbs. per foot. The draft-gear is placed between the center sills, not below them, the end sills are 12 in. deep so that a sufficiently large hole may be made for the drawbar. The longitudinal sills are tied or braced together transversely by bolts having distance pieces of gas-pipe upon them, and longitudinally by diagonal tie-rods fitted with turn-buckles, and with their ends strung on the same transverse bolts with the gas-pipe distance pieces, thus tying the six longitudinal sills together in each direction. The body bolsters are of the well-known plate pattern which have been a long time in successful use, the bottom plates of the bolsters being supported by diagonal braces to the center sills. The connections between each sill and body bolster to sills are all made by the use of steel angle irons 3½ in. × 3½ in. × $\frac{7}{16}$ in. and of ¾-in. turned bolts put in a good driving fit. The sills are trussed by four rods 1¼ in. diameter, and having 1½ in. screwed ends with heavy wrought-iron plate washers. The needle beams are steel ties 5 in. × 3½ in. bolted to the side sills; the struts are of malleable iron, the whole truss being made very deep. The draft pockets are intended to be of pressed steel, but in this sample car are forgings. Each pocket is bolted very securely to the center sill by 10 bolts 1 in. diameter turned and driven in, forming the strongest attachment ever applied to an ordinary freight car in this country, the bolts being able to withstand a shearing strain of nearly 400 tons; the follower plates are made as short as possible, of wrought iron 2 in. thick, the regular Pennsylvania Railroad standard draft spring being applied, with a supplementary buffing spring behind horn of coupler. The platform is made in four distinct lengths, each length being held in place by six or eight bolts ¾ in. diameter, so that when these bolts are taken out a whole section of platform can be lifted off for examination, painting, or repair of platform or sills. The designs for this car were made after laying down certain principles which, I am persuaded, ought to be embodied in the construction of every metal car frame. I felt that, if we adhered to them, we could with safety count upon the service which the car would give us, and that it would be entirely satisfactory. These principles were:



STEEL CAR, DESIGNED AND BUILT BY THE NORFOLK & SOUTHERN RAILROAD.

TEST LOAD, 147 CAR WHEELS, WEIGHING 80,000 LBS. AFTER TEN DAYS, TOTAL DEFLECTION ⅝ INCH. PERMANENT DEFLECTION, ⅛ INCH.



IRON CAR, BUILT BY THE NORFOLK & SOUTHERN RAILROAD; G. R. JOUGHINS, SUPERINTENDENT OF MOTIVE POWER.

1. That the car should be made amply strong enough to support the weight it was designed to carry; 2. That only the common rolled sections of steel or plain forgings should be used, except for the draft pockets and such details as are special on timber cars; 3. That no rivet should be used in its construction; 4. That no holes whatever should be allowed in the flanges of the beams; 5. That all work should be first class, equal in quality to locomotive work; 6. That the ultimate weight and cost of the car should be entirely secondary considerations. The first requirement, "That the car should be made amply strong enough to support the weight it was designed to carry," was understood to mean that it should be quite capable of carrying a load equally distributed over the platform equivalent to the rated capacity. This was carried out by selecting channel irons of such a section that the six sills combined are able to carry with perfect safety a distributed load of 400,000 lbs. on supports placed 1 ft. apart. To impress upon you the great difference in strength between this steel car and the tubular car, I must tell you that this weight is 16 times as much as could be supported under the same conditions by the eight tubes composing the sills of the tubular car; and this advantage is mostly obtained by putting the same weight of metal per foot of sill into a better form, the balance of the increased strength being gained by using six sills instead of four. This comparison shows up very vividly the weakness of the sills in the tubular car and explains why the tubes so soon become distorted. In trussing the sills of our steel car advantage is taken of the space beneath to make the truss very deep. It is 21½ in. below the sills, and its total depth is 28 in., which is, I think, greater than any hitherto used in car work. The truss-rods are calculated as the tie-rods of a queen truss, and therefore perform their proper function of entirely supporting the load between the bolsters, and are strong enough to sustain their share of a distributed load of 80,000 lbs. on the car, therefore making this a frame of 80,000 lbs. capacity. In fact, the frame can easily be converted into one able to support 100,000 lbs. by simply strengthening the tie-rods and struts. As it can be proved that the free ends of the sills which overhang beyond the body bolster, and which are the weakest part of the car because they cannot be trussed, have a combined strength sufficient to carry their proportion of an equally distributed load of more than 100,000 lbs. over the whole platform; and if the truss were made heavy enough a safe load of 190,000 lbs. could be piled upon this car, an enormous load compared to the net weight of the car. You may notice that the struts are inclined to the vertical, so as to bisect the angle formed on the tie-rods, the change from the usual practice being made because it is more correct in theory and more in conformity with the strains transmitted. You may, perhaps, ask me why I have made a frame capable of supporting so great a weight. I would reply that a car is called upon to resist many heavy strains beyond those required to support its load. It has to stand buffing and pulling strains, corner strains, side strains, torsional strains on side sills, strains reaching through the truck, and many others, all of which have their effect upon the various members, which must be made strong enough to absorb them. Besides that, I think it would not have been wise to use smaller or lighter beams; the saving effected in weight by using 6-in. beams instead of 8-in. would have been only about 600 lbs., and the reduced cost very little indeed. I merely mention the enormous weight which the car would carry to show what can be effected by using economical sections in the beams and by proper and efficient trussing.

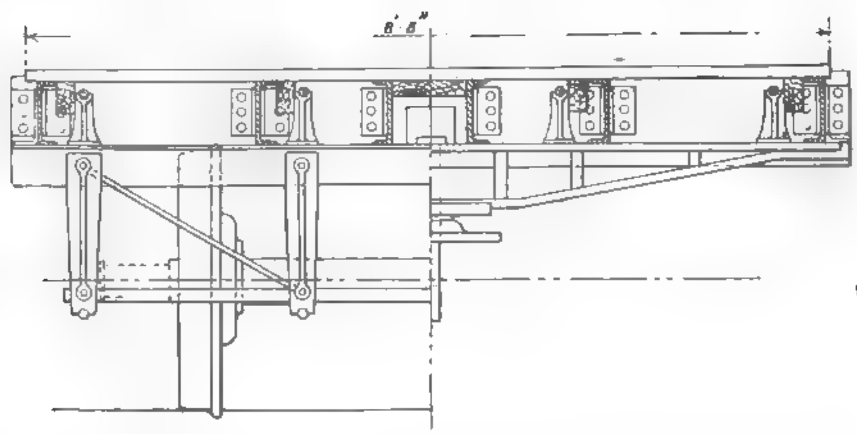
The second principle, "That only the common rolled sections of steel or plain castings

or forgings should be used," needs no explanation, and I think we have succeeded in fulfilling the requirement.

Before laying down the third principle, which says "that no rivets whatever should be used in its construction," much consideration was given to the question, "What is the most desirable, efficient, and durable fastening for attaching together the various members of a steel under frame?" This, to my mind, was the most important question involved in the details of the car, as upon its successful solution depends the very life of any metal under frame which we may attempt to construct. The question is one which at first sight appears to have only one answer, and that is to use rivets. From the remotest times rivets have been used in all countries for fastening together pieces which were required to be held together in the tightest possible manner. We build our boilers, our bridges, our ships with them; and many examples could be pointed out in the practice of other countries—and, indeed, in our own—where rivets have been more or less successfully used for this very purpose of fastening together details of rolling stock. But I felt that the conditions obtaining in metal under frames in this country were different from the conditions obtaining in other previous structures. I also have had experience with tender frames and freight-car trucks, and could only come to the conclusion that rivets are not reliable, unless certain conditions, which are very difficult to fulfil in a metal under frame, are complied with. These conditions are, that the joints or connections between the several pieces should be made large so that many rivets could be used, and that all rivets should be put in by machinery, in order that they may support each other and prevent that first small movement which is so fatal. I know that riveted structures can be pointed out on every side in which rivets prove themselves perfectly good for all time, but I submit that the conditions which rivets are required to meet in boilers, bridges, etc., are altogether different from the conditions they would be asked to meet in car work. In the permanent structures mentioned there is a very large number of rivets and very little vibration; in a car frame, and especially the long car frames of this country, the vibration is very great, and the rivets connecting each joint must necessarily be few; there would be a great number of intermittent stresses put upon each rivet, gradually lessening them one by one. I distinctly admit that this would not occur if sufficient rivets could be used, and it is one of the good points of design in the Fox truck that very large joints are made and plenty of rivets used, in contradistinction to the small number of rivets which are often used in the diamond style of truck, and which are so difficult to keep tight, there are not enough of them, they do not support each other, and in consequence become loose in a comparatively short time. As black bolts are evidently out of the question, the only conclusion which could be reached is that the most desirable, efficient, and durable fastening from every point of view would be turned bolts having a good driving fit, the workmanship required being equal in all respects to that put upon our locomotives, which would mean that not the slightest degree of looseness could be found in the structure. The use of such bolts would also include a number of other advantages when the cars are in service and when they require repairs; and, finally, it can be easily shown that they would be cheaper and lighter than rivets, because the joints would not require to be so large nor the fastenings so numerous.

To prove that turned bolts are perfectly reliable and efficient for continued use in a structure subjected to large and constant vibration, I have only to point to our locomotives and other prime movers, where bolts are subjected to ever-varying strains in intensity and direction in the main rods and other parts, and to the built-up car-wheels which run on all the principal roads of the country. I am particularly indebted to Mr. Boies, of the Boies Steel Car-Wheel Company, for describing the bolt which he uses for attaching together the two thin plates forming their built-up wheel, and which I have adopted in a modified and cheaper form on this car by making the bolts parallel instead of taper. The principal feature of this bolt is that the body is made long enough to be a driving fit completely through all the plates which are to be connected together, so that, however thin the pieces are, the body of the bolt fits perfectly tight into each piece, the screwed part therefore projects beyond, and the nut is countersunk enough to allow it to be tightened up. Mr. Boies takes extraordinary precautions in the fitting of the bolts, and says that he does not recollect ever having heard of a nut unscrewing or coming off, but the usual method of fitting driving bolts would, of course, be all that is requisite for car work.

The fourth principle laid down is, "That no holes whatever should be allowed in the flanges of the beams." This requirement is, I believe, of the utmost importance. It can be easily seen that if a hole be drilled through the flange of a channel iron its strength is very greatly reduced, but I believe that much more mischief than the weakening of the beam would ensue. I feel sure that wherever a hole is in the flange that ultimate breakage is certain to result, starting from that hole. This is especially true of steel beams. It would be exactly like nicking a bar of steel, the serious effect of which is so well known, and the beam would act in precisely the same way, subjected as it would be in car work to great vibration. Some new ideas in car construction are therefore introduced for fastening the platform and under rigging to the main frame.



END ELEVATION AND SECTION AT BODY BOLSTER OF N. & S. R.R. IRON CAR.

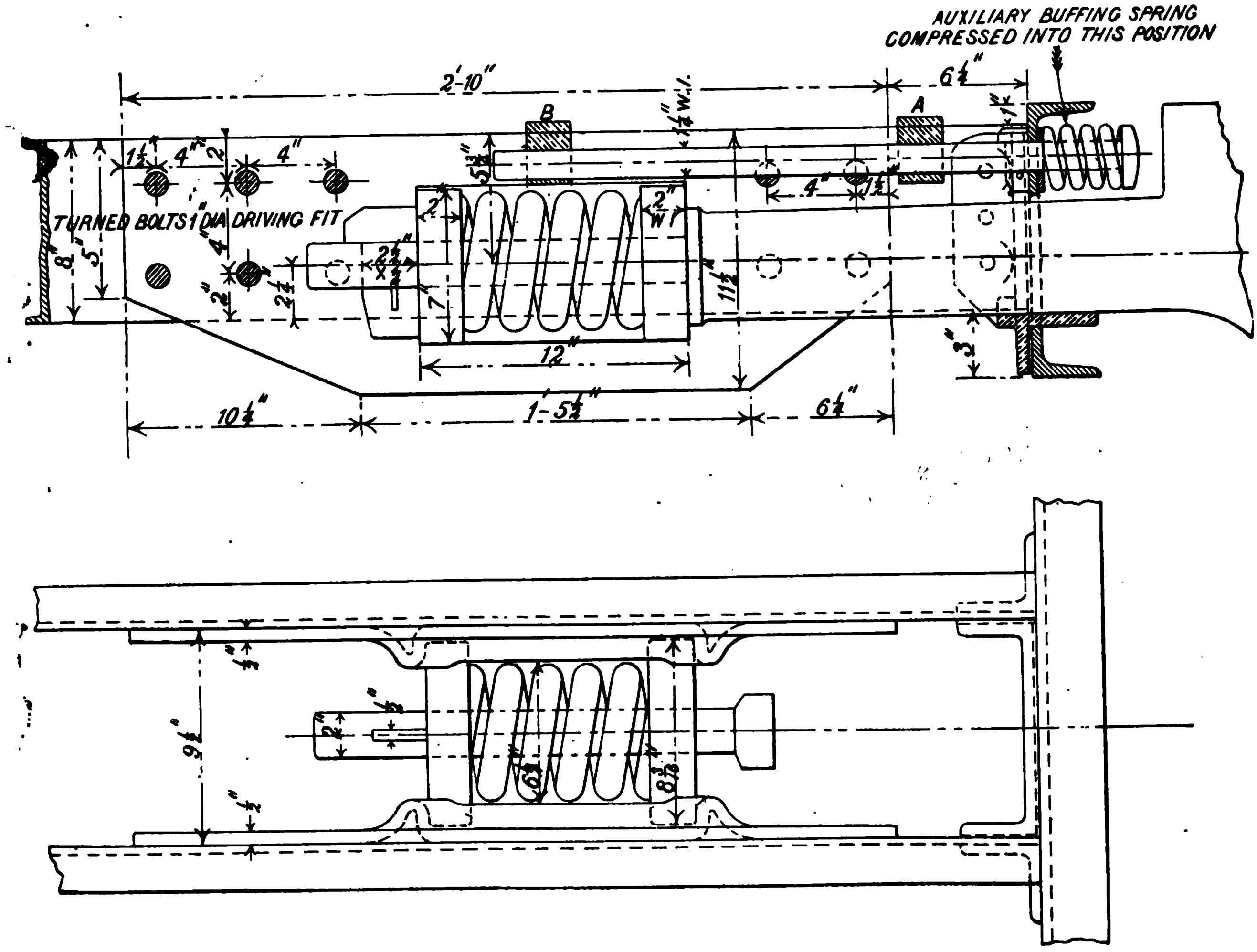
The fifth requirement, "That all work should be first class, equal in quality to locomotive work," speaks for itself. That the expense would be justified by results I am well convinced, but the extra cost need not be great, the requirement only means that extreme care be taken to make the first few cars with strict exactness, that the parts should be perfectly interchangeable, that the holes should be made an exact size, and the bolts properly turned and fitted. Such work can be done very cheaply. With suitable tools and proper organization holes can be drilled for one-quarter cent each, and bolts can be finished from the forge at less than one cent each, an increased price over black bolts not worth a moment's consideration.

The sixth principle, "That the ultimate weight and cost of the car would be entirely secondary considerations," is, of course, to be understood as within reasonable limits. It was laid down to try and escape as much as possible the temptation to make everything so light and cheap that there might be some doubt about its efficiency; in other words, the dominant idea was to be certain to make everything strong enough, leaving the future to disclose what parts might be made lighter and what braces and details might be dispensed with. The result, so far as the weight is concerned, is certainly very satisfactory, the frame with platform weighing only 2,000 lbs. more than the frame of the tubular iron car, the total weight (without brakes) being 20,300 lbs.

Respecting the cost, I would say that we intend soon to get some cars made exactly the same as this experimental one. We therefore sent specifications to some makers, and were agreeably surprised to find that, although the car is an entirely new departure, yet the figures submitted agreed, as near as possible, with the cost which we had estimated they could be built for. We think these figures are very reasonable, and so long as we can get metal car frames made at such prices, we shall never desire to buy wooden ones.

The first test of this experimental car was made by placing upon it, as its first load, 147 car-wheels weighing 80,000 lbs., leaving them there for 10 days, and in the mean time moving the car several times through the yard and to the scale track 1 mile away. At the end of this time the sills were found to have a total deflection of ⅜ in., and when the load was removed a permanent deflection of ¼ in., amounts which are very small and which show the great strength and rigidity of the frame.

The car has now been in constant use for 14 months, and has given very satisfactory service. Not one cent has been expended for repairs, and not a single bolt or nut has yet become loose. As our idea in building this experimental car was to discover weak places before ordering a number, we have had it in the shop many times for examination, and can only discover one weak place—that is, a slight deficiency in resistance to torsion of the side sills; they are twisted a little by heavy loads of pine logs, three or four tiers high, which wedge themselves down against the stakes, producing a large twisting movement, but this deficiency can be very easily overcome. We also find that the castings protruding through the end sills for supporting the drawbar are broken, but the breakage is not significant, and was caused simply by using iron castings instead of steel ones, as intended. These are absolutely the only defects which we can find, and they do not affect the the gratifying results in the use of tubular iron cars which we obtained, but, as a result of our experience, I unhesitatingly express my profound convictions that steel frames can be designed and built which will secure these advantages on any road, that designs will develop for cars possessing greater strength and efficiency as experience dictates, eliminating the weak points, and proving that steel is the only material which ought to be used for this purpose in this age of steel. I am convinced that the cost of repairs could then be reduced to an extremely low figure. There is nothing to wear out except the running gear, nor is there anything but the platform and paint which will deteriorate by age. The period of their life would depend simply on questions of improvement, of heavier weights to be carried, and on the fashions of the times, otherwise the metal car has an indefinite life, great strength, and unlimited endurance.



DRAUGHT RIGGING OF IRON CAR ON THE NORFOLK & SOUTHERN RAILROAD.

principle or ultimate value of the design in any way whatever.

I believe that the advantages to be derived from the use of steel car frames are manifold, and of importance to all railroad companies. It is certain that on our railroad, and in such a climate as ours, we feel well assured that steel possesses great superiority over wood in strength, cost of maintenance, and endurance, and that it is the only material which we could consistently use in the future for frames of all flat and gondola cars, and probably for box cars. We consider that we have proved completely that it has the advantages claimed. With such a frame we should be well prepared for the next demand for increased capacity, and I would feel inclined to strongly advocate that trucks of 80,000 lbs. capacity should be placed under these frames, even though it might not be desirable to carry such loads at the present time. I am also deeply imbued with the belief that on nearly every railroad in this country steel frames could be successfully used, and that increased economy, efficiency, and durability would follow their adoption. I do not mean to say that other railroads could secure

Mr. President, I am not alone in believing that there is a great future for the steel car frame. I can refer to our technical papers, which go so far to mold the opinions of every railroad official. They seem to be unanimous in advocating its possibilities. *The Engineering News* of May 19, 1892, has a very able editorial on "The *Pros* and *Cons* of Iron Car Construction," in which the writer shows that iron cars are economical because they reduce the dead weight to be hauled, independent of all questions of reduced cost of maintenance, and says: "Those facts lead us to believe that steel car construction has come to stay and to rapidly increase . . . and with a capacity of perhaps 100,000 lbs. With such cars, all equipped with train brakes and close couplers . . . freight rates may touch depths not dreamed of yet, and still leave a larger profit on each ton handled than is realized to-day." *Locomotive Engineering* for August, 1893, has an editorial headed "Steel Under Frames for Cars and Tenders." The argument in favor of steel frames is put very forcibly and concisely. It says: "When the strength and durability of steel is compared with wood, it seems strange that car builders on this continent

have done so little to apply the stronger material to the principal members of a freight car. . . . We believe that the subject needs to be agitated, and that railroad companies would be the gainers by extended investigation and discussions on the subject of metallic under framing." *The Railway Age and Northwestern Railroader* says: "The tendency toward the use of metal is seen in car framing, and while not particularly exemplified in practice, is still strongly revealed in the current opinion and talk of some of our best mechanical officers . . . the car made in its practical entirety of steel is to-day considered as well within the range of probabilities for the comparatively near future." *The Railroad Gazette*, in an editorial of June 9, 1893, says: "What is most needed to gain the least cost of carriage per ton mile is a set of standard metal frame freight cars with uniform trucks. . . . If some of our progressive roads would take up this matter, and build perhaps 1,000 cars with steel under frames, or at least steel center sills, and do the work in the same thorough way that bridge work is done, there would be within five years' time some practical knowledge of real value that would bear upon the subject and be a safe guide for the future."

At the last convention of the Master Car-Builders' Association the following sentence appeared in the report of their committees: "When metal sills come into use it might be possible, on account of the changes which will be necessary in the draft-gears of most companies, to arrive at a standard. . . . We believe the time for the substitution of metal sills is approaching." We know that in some foreign countries steel under frames have been successfully used for many years, and in response to my inquiries the President of the German Railroad Commission writes in reference to steel frames for cars: "Such a construction is unchangeable, and is stiffer than that of wood, besides being perfectly fireproof, while the expense of maintenance is less." The Superintendent of Motive Power of the Western Railroads of France says: "I have the honor to inform you that metal frames have been substituted in an almost general manner for wooden ones in cars of recent construction." Perhaps the strongest argument which I can present for metal under frames is a copy of the statement which influenced our opinions and determined our conclusions in favor of metal cars. The statement shows the repairs executed from April, 1890, to April, 1893, on the 50 cars which we had leased from the Iron Car Company, and the cost of these repairs. It will be seen that two cars were wrecked. With that exception you will notice the light character of repairs executed, and the fact that absolutely none were required upon the under frames. This good record was made in face of the fact that the cars have during the whole five years been carrying heavy loads, and always run in trains containing 50 or 60 cars. Nor must it be supposed that the frames required repairs which they did not obtain; on the contrary, the cars have been always in good condition, and the frames for all practical purposes are as good as new. At the end of our lease, in August last, these cars were inspected by Mr. C. W. Walker, Master Mechanic of the Seaboard & Roanoke Railroad, and Mr W. A. Brown, Master Mechanic of the Atlantic & Danville Railroad. Their report shows that the only defect which existed in the under frames was one damaged tube or sill.

The total cost of repairs to these 50 iron flats for three years, leaving out wrecks, wheels, and brasses, has been $163.32, an average of $1.10 per car per annum. I must say, however, that the timber platforms will soon require thorough repairs, and the iron work needs a coat of paint.

For the purpose of contrasting our experience with metal frames with the experience of other people having timber flat cars, I made numerous inquiries with the hope of obtaining the cost of maintenance of such cars, their average life, and the percentage of repairs and rebuildings due to wrecks, but was unable to procure any information from which general conclusions of value could be drawn. The average life of such cars was given as from seven to 17 years; and in reference to the percentage of repairs and rebuildings due to wrecks, I can only quote what was said by Mr. Barnes at the last Master Car-Builders' Convention, that it amounts to 6 per cent. on large roads. Therefore the only statement which I can submit as to the cost of repairs of wooden cars is one from my own road showing cost of maintenance for 50 wooden cars for the same three years. I must, however, say that these timber cars were three years older than the iron ones, and the peculiarly destructive effect of our climate must not be forgotten. This statement shows the total cost of repairs to 50 wooden flats for three years, leaving out wrecks, wheels, and brasses, has been $2,664.49, an average of $17.76 per car per annum, 17 times as much as the iron cars which, I think, gives a sufficient reason for our preference in favor of these cars, and proves conclusively that metal frames are superior to wooden ones, if only they are built to suit the heavy traffic of to-day, and with strength commensurate to the work and abuse to which they will be subjected. If they are built strong enough it is difficult to predict how far-reaching the results from their use may be. The latent possibilities of the steel car are unlimited, and it is certain to triumph in the end; and if I have induced you to look at this question from my point of view, it only remains for you to consider whether the time has yet arrived for the general introduction of steel cars on the railroads of this continent, or whether the work is to be left for the next generation to accomplish.

MARINE NOTES.

Unsafe Gunboats.—The report of the Naval Stability Board, that was appointed to inquire into the defects on a number of the war ships, has been submitted to the Secretary of the Navy in reference to the *Machias* and *Castine*. The Board said that these gunboats are top-heavy and unstable and recommends that the two vessels shall be lengthened 14 ft. The estimated cost of the alteration is $30,000.

The Proper Color for Torpedo Boats.—Germany's naval experts have decided that the best color to paint their cruisers and torpedo boats, in order to make them as difficult of observation as possible, is a kind of dirty buff. They recommend that the whole of the vessels should be uniformly coated with this color, and that nothing on their decks or upper works should contrast with it.

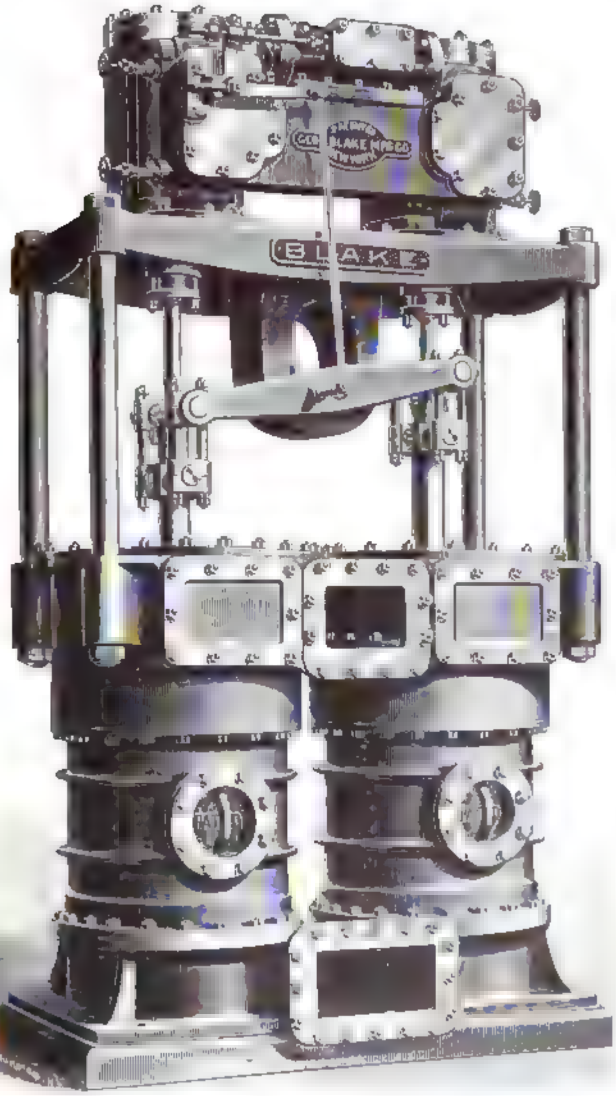
Wooden Ships in the Navy.—The old wooden ships of the Navy are gradually being retired from active service. The flagship *Lancaster* is now on her last cruise. When relieved by the *Baltimore* she will return to New York and be transformed into a receiving ship, to take the place of either the *Minnesota* or *Vermont*, which are both in a state of decay. Another ship that will soon follow the *Lancaster* to the graveyard of all old naval vessels is the *Alliance*, now at San José. She will leave in the next few weeks for New York, and is also to serve as a receiving ship. The *Marion*, *Mohican*, *Adams*, and *Yantic* are still in service, but their days are numbered. The *Yantic* is in the South Atlantic, and will return home shortly to be placed out of commission. She is now on her last cruise. The *Adams* is not good for many more months, and the *Marion* is little better. There will be two wooden vessels in the Navy for many years, however, as, by special act of Congress, the *Hartford* and the *Kearsarge* are exempted from the repair limit of 10 per cent., and will thus be saved. The *Hartford* is being rebuilt, and will prove a good vessel for many years, and the *Kearsarge* is now in fair condition. But with the exception of these two every wooden ship in the Navy will disappear within the next year or two.—*Washington Star.*

PROCEEDINGS OF SOCIETIES.

Engineers' Club of Philadelphia.—At the meeting of this Club on January 6 Mr. A. Falkenau described some interesting features in the department of mechanical engineering at the World's Fair. He expressed the opinion that the disappointment expressed by many engineers regarding the mechanical exhibits was partly due, not so much on the part of the exhibitors as to the fact that the different fields of the application of power had been so thoroughly exploited that novel forms are few, and advance is confined to minor details. He gave a full description of the Yerkes telescope, some air compressors, and certain riveting machines.

Engineers' Society of Western Pennsylvania.—At a recent meeting Mr. D. Ashworth read a paper entitled "Indifference to Boiler-firing and Management." He stated that in experience extending over a period of a quarter of a century he had found that there had been a continuous decline in the grade of service of those in the positions of firemen and boiler-room managers, that the evil had become so glaring and the results so palpably fraught with disaster, destruction and waste, as to warrant an effort to call the attention of those who desire to progress to the false and inconsistent position which they occupy, by permitting such a narrow policy in management, so widely at variance with true economy, ignoring directly that the better intelligence renders the more valuable and hence more profitable service. He stated that the intelligent engineer keeps a constant oversight over every part of the steam plant, and is familiar with the elements of com-

bustion and the importance of proper management of fires to produce the greatest results with the least expenditure of fuel. It has been said that this is greatly overcome by the application of mechanical stokers, but this is a mistake well known by those conducting tests, the results being always superior with the greater intelligence of the operator of the machine. What is greatly needed at present is to lay aside the idea that any one is good enough to fire and manage boilers. The reason why a better class of skill is not obtained for this work is that it is not sought, and just as long as this class of operators is looked upon as mere shovelers, throwers of coal and carriers of water, ignorance, with all its attendant waste, destruction of property, and general demoralization, will be prominent in the department. As a fitting close it would be proper



THE BLAKE VERTICAL TWIN AIR-PUMP ON THE U. S. CRUISER "NEW YORK."

to ask what degree of intelligence or knowledge would qualify one to fire boilers properly ?

1. That the fire should be maintained with uniformity, and that no openings, in the form of bare places, showed upon the bars to permit cold air to pass through.

2. The judgment that will enable him, by a glance at the ash-pit, to know at once, to a great extent, the condition of the fires.

3. He should know something of the various fittings of the boilers, such as valves, etc., and the details of the furnaces.

But not least, an ambition to grasp the details, so as to qualify him for a still higher plane, which would certainly follow, provided there was judgment enough in the superior to note such details.

Sufficient, we think, has been said to convince the most obtuse mind that the indiscriminate employment of labor for this purpose is a crying evil, and some consideration given to the claims here made, that, simply because one can shovel and throw, it does not follow that he is qualified to fire and have charge of steam-boilers.

AIR-PUMPS ON THE UNITED STATES CRUISER "NEW YORK."

Our readers will remember the illustrations in our last number of the United States armored cruiser *New York*. We now publish particulars of the independent air-pumps, which in their way are quite novel in construction and performance. The cruiser *New York*, like all the Government vessels, has very little room to spare for the engines and their auxiliaries, consequently the design of the air-pump had to be one combining compactness, minimum weight, and maximum efficiency. As shown by the illustration, the design of this pump is of the vertical twin single-acting type, Blake system. The air cylinders are of the well-known vertical, single-acting type, operated by steam cylinders on the direct-acting system ; there being two air cylinders, the operation is practically continuous or double-acting. The piston-rod on each side of the pump is connected to the beam by means of links, etc. The air cylinders and the working parts of same are entirely of gun-metal composition, which is the usual practice in the United States Navy. The piston-rods in the steam cylinders, as well as the valve gear, are of steel, and the latter is so arranged that it can be adjusted by hand even while the pump is in operation, thus securing full stroke at all times.

These pumps are particularly remarkable for their economy—that is to say, for the low percentage of the power required in comparison with the power of the main engines. From the official report of the trial trip the indicated H.P. of the Blake air pumps was less than one-quarter of 1 per cent. of the indicated H.P. of the main engines, a result that has, we believe, never before been attained in marine engine practice. The explanation for this small amount of power required to do the work is perhaps due to the very complete and perfect arrangement of the steam valve gear, which thoroughly controls the operation of the pump, so that a very low rate of piston speed is sufficient to give a first-class working vacuum. As an illustration, the average speed of the air-pumps on the trial trip of the *New York* was less than 16 double strokes per minute, while the minimum speed was only 9¼ double strokes per minute. The pumps are so positive that they can be run at practically any speed desired without the slightest danger of being caught on a dead center, a feature which, of course, is impossible with a crank and fly-wheel type of independent air-pump. In fact, these pumps have been so successful that the William Cramp & Son Ship & Engine Building Company have placed them on all the other vessels they are building for the Navy—namely, the *Columbia, Minneapolis, Brooklyn, Indiana, Massachusetts*, and *Iowa*.

Each of the *New York's* air-pumps has two double-acting steam cylinders 12 in. diameter, two single-acting air cylinders 25 in. diameter, the stroke of all being 18 in.

The working parts of this pumping engine are exceedingly simple and strong. The valves for the steam cylinders are plain D slide valves, which are operated through levers by a supplementary piston moving in the horizontal steam cylinder shown. This supplementary piston is in turn operated by a plain D valve connected to the valve-rod, having adjustable collars for regulating the stroke. This valve-rod is moved by means of the rod attached to the working-beam from which it gets its motion, and which is clearly shown in the engraving.

New Material for Electrodes.—A species of fungus has been found to be well adapted for the making of electrodes for external use in electro-medical operations. Felt, cotton and clay have not been altogether satisfactory for this purpose. The fungus grows on old trees in Europe. When prepared for the above use it has the appearance of soft leather, and is very porous. It is found to be an excellent conductor, and besides readily conforms to the irregularities of the body.

Fast English Cruiser, the "Destroyer."—The Admiralty have placed an order with the Naval Construction Company, of Barrow, for a first-class cruiser. She is to be 300 ft. long, with a speed between 23 and 24 knots.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

Formerly the RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

The American Railroad Journal, founded in 1832, was consolidated with Van Nostrand's Engineering Magazine, 1887, forming the Railroad and Engineering Journal, the name of which was changed to the American Engineer and Railroad Journal, January, 1893.

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NEW YORK, MARCH, 1894.

EDITORIAL NOTES.

THE *Paris* has now suffered from two accidents, in each of which the value of the twin screw has been demonstrated. In the last accident, wherein the rudder was disabled, the remarkable feat of navigating a vessel for 500 miles, a part of it in heavy weather, by means of the screws alone was accomplished. To any one who has attempted to steer a vessel in a heavy sea, and knows the constant vigilance and work at the wheel which is required, the fine adjustment of speeds of the screws, and the constant variation of the same that would be required, makes the work done on this trip out from Southampton and return seem a little short of the marvelous.

WHEN the *El Cid*, now the *Nictheroy*, was purchased and sent south to help quell the Brazilian rebellion, it was expected that she would do a vast amount of work in settling some questions that have been vexing the spirit of naval experts for many years. There was the dynamite gun, located forward to prove its efficiency or worthlessness; but as far as we can learn, not a shot has been fired, and the gun might as well be in New York as in Brazilian waters. Then there was the fast unarmored cruiser pitted against powerful battleships. Which wins? No fight, no shooting, and problem still unsolved. Our nature is not naturally bloodthirsty, but we feel that the dynamite gun as a fighting mechanism has never had a chance to show its worth or worthlessness, and in the interests of mechanical science we would like to know what can be really expected or feared from such a vessel as the *Nictheroy* now is.

LAST July we made the remark, in commenting on the discussion by the Association of Master Mechanics on the compound locomotive, that from the mass of contradictory testimony it was difficult for an unprejudiced observer to tell "where he was at." We would call attention to two reports from widely different sections of the country, published in other columns of this issue, which go to show that a very decided saving of fuel is effected by the compound. This seems to be assured, but the unprejudiced observer is still looking for data regarding expense for repairs, and on this point information seems to be difficult to procure. There seems to be no good reason why a well-designed compound should be more expensive to maintain than a single engine, except in the matter of the larger cylinder; but the very fact that they are new, that none has ever worn out, and that repair records are not published serves as a check upon their introduction.

MEETINGS OF MEMBERS OF THE SOCIETY OF MECHANICAL ENGINEERS.

THE second meeting of the series, which has been inaugurated this winter, was held in the hall of the Society on the evening of February 14. The subject for discussion at the first meeting—"The Development of Stationary Engines, as illustrated by those exhibited at the Columbian Exhibition in Chicago"—was continued. Professor John E. Sweet, of Syracuse, read an introductory address, which will be found on another page, with an abstract of the discussion which followed. There were about 80 members present.

The two meetings which have been held, under the auspices of a committee appointed at a meeting of members held last November, have been very promising of success to the scheme. When they were first proposed objection was made to having these meetings of the Society, on the ground that few non-resident members could attend them. It was somewhat of a dog-in-the-manger argument, but was regarded by those who wanted to hold such meetings. They claimed the right of coming together in the rooms of the Society and discussing any subject they chose, and therefore the meetings were called as meetings of members of the Society merely, and not meetings of the Society itself. Now, however, fault is found by a correspondent in the *Railroad Gazette*, that the Society does not publish the proceedings, and he claims that the non-resident members have a right to them, and are deprived of what they may reasonably expect to get. It may be said here that a reporter has been employed to make verbatim reports of the discussions, and that any newspaper or other party can have copies of these reports by sharing its or his proportion of the expense. THE AMERICAN ENGINEER, the *American Machinist* and *Engineering News* are the only papers which have thus far agreed to enter into this arrangement.

The next meeting will be held on Wednesday evening, March 14. The subject for that evening will be "*Testing Machines and Tests of Materials.*" The introductory address will be by Mr. J. Sellers Bancroft, of Philadelphia, who will describe the recent improvements which have been made in the Emery system of testing machines.

Members have the privilege of inviting friends, and it is proposed to issue blank cards of invitation to the members which can be used as they see fit. The next meeting promises to be of great interest to all who are concerned in the tests or testing of materials used in engineering.

THE LIMIT OF INTELLECTUAL ELASTICITY OF AN AVERAGE AUDIENCE.

IN Balfour Stewart's admirable "Lessons in Elementary Physics" he says: "There is a limit within which a body may be temporarily acted upon with the certainty of its recovering its figure when the force is withdrawn, and this limit is called the *limit of elasticity*, the word *elasticity* denoting tendency to recovery. When this limit is overpassed the body does not recover itself, but becomes weaker and weaker, until at length it yields to the applied pressure."

Some intellectual phenomena seem to be controlled by an analogous law. Our minds may be subjected to a given amount of tension, not exceeding a certain limit, with the certainty of recovering their original attitude; but if taxed beyond this limit, our attention becomes weakened until finally apprehension fails, and "the subsequent proceedings interest us no more."

The existence of a physical limit of elasticity in solid bodies may be proved from certain phenomena which occur when such bodies are subjected to tension. In a similar way we may study the intellectual phenomena which are manifested when an audience is "acted upon," and the minds of those who compose it are in a state of more or less tension, and we may thus deduce some of the laws which control the mental operation of an assemblage of people.

But, as some logician has asked, "On what principle do we decide, in watching a succession of phenomena, that they are connected as cause and effect, that one happened in consequence of the happening of another?" In the present instance we may adopt John Stuart Mill's statement of the principle which may be adopted in an investigation of this kind. This statement he calls the "canon of the method of difference," and it is as follows:

"If an instance in which the phenomenon under investigation occurs, and an instance in which it does not occur, have every circumstance in common save one, that one occurring only in the former, the circumstance in which alone the two instances differ is the cause, or an indispensable part of the cause, of the phenomenon."

To apply this method in determining whether an ordinary assemblage of people has any intellectual limit of elasticity, we need "an instance" in which a body of people is subjected to a limited degree of mental tension, repeated many times, and from which they always regain what—to use Balfour Stewart's physical phraseology—we may call the "figure" of their minds.

Then we need another instance in which the limited degree of mental strain referred to is "overpassed," and from the repetition of which the audience does not recover, but its attention becomes weaker and weaker, until at length it fails altogether to apprehend the discourse to which it is subjected.

Happily for our hypothesis and for our investigation, we have two such instances. The one was anticipated by a notice dated February 5, in which it was said that

"The second meeting of Members of the Society of Mechanical Engineers for the discussion of subjects pertaining to their occupations will be held in the hall of the Society, at No. 12 West Thirty-first Street, New York, on Wednesday evening, February 14, at 8 P.M. The subject which was discussed on January 10—'the DEVELOPMENT OF STATIONARY ENGINES, as illustrated by those exhibited at the Columbian Exhibition in Chicago'—will be continued at the next meeting. The introductory address will be by Mr. John E. Sweet, of Syracuse, N. Y. The subject will then be open to general discussion."

The other was announced as follows:

"The next meeting of the New York Railroad Club will be held at 12 West Thirty-first Street, on Thursday evening, February 15, 1894. Mr. R. A. Parke will read a paper entitled 'The Vertical Influence of Counterbalancing' (on locomotives). There will be proofs of the text and illustrations for distribution among members present."

The introductory address of Professor Sweet, which was read at the meeting of Mechanical Engineers, will be found on another page, with part of the discussion thereon. The other paper on Counterbalancing, owing to the limited space available in THE AMERICAN ENGINEER, the hard times, the heavy expense of setting up a great many abstruse mathematical formulæ, and for other reasons has not been republished, nor would our readers probably be much interested in the discussion which followed the paper. The two meetings, however, supplied the instances which Mill says are needed to determine that the succession of phenomena, which were manifested, were connected as cause and effect—that is, the two meetings "had every circumstance in common save one," and the phenomenon under consideration occurred at the one meeting, and did not occur at the other. Or, to express it differently, the audience in the one case was acted upon by intellectual forces repeated temporarily many times, and in each case it recovered its "figure," and, apparently, when the discussion was ended the apprehensive capacity of the audience was as great as when the meeting began. On the second evening, however, it was obvious that the elasticity or "the tendency to recovery" of the attentions of those present was "overpassed." As already remarked, the two meetings "had every circumstance in common save one"—that was the character of the papers. Our readers may judge of Professor Sweet's paper themselves—probably few of them will begin reading it without finishing it at one sitting. It is clear and incisive, with veins of humor running through it like the striations in a crystal. There is not a dull or obscure line in the whole of it, and it has pre-eminently the merit of lucidity. When he ended the reading of it there was a general manifestation of resilient satisfaction through the whole audience. Each individual seemed to recover his mental spring the moment the professor relieved the gentle and agreeable strain on their attention.

It may be said of an audience as Mr. Clark—in his work on the Britannia and Conway tubular bridges—said of girders, that "time is an important element in producing the ultimate permanent set in any elastic material." In all the wrought-iron girders which he tested, he says that "a considerable time elapsed before they attained a deflection which remained constant." That this principle is a law of intellectual as well as physical statics was recognized by the Committee which has charge of the meetings of the Members of the Society of Mechanical Engineers, in the rule which has been adopted by them, requesting the principal speaker of each evening not to occupy more than 30 minutes, and limiting those who take part in the discussion thereafter to five minutes. For such periods of time an audience will have the power of resisting a degree of strain without deformation, which, if imposed for longer periods, would result in an enduring stretch, which may be manifested by frequent yawning and lateral deflections. At the meeting referred to, the demands made upon the attention of the audience were much below the elastic limit, both in the introductory address and in the discussion which followed. When the meeting ended the audience seemed to rebound, and was in an alert and even jovial state of mind. All were apparently interested and entertained, some were instructed, and probably others will ultimately be pecuniarily profited by reason of being present. Many of those who were there congratulated others who were present on the fact that there had been "a good meeting." As these meetings are to a considerable extent experimental—the one referred to being only the second one of the series—the interest which was manifested was especially gratifying to those who, in a measure, are responsible for them and for the manner in which they are conducted. That the attention of the audience was not stretched beyond its intellectual elastic limit was, however, obvious, and was due to a very considerable degree, if not entirely, to the fact that those who took part in it recognized that "a listener has at each moment but a limited amount of mental power available, and it is of the utmost importance that this attention should be economized, and that ideas should be presented so that they may be apprehended with the least possible mental effort."

As a contrast to this meeting, the one held on February 15

may be quoted. The paper which was then read occupied 30 pages of closely printed minion type, interspersed from beginning to end with mathematical formula, of a high degree of tensile strength, or, to use a more expressive synonym, they were *tough*. It would be a very useful investigation, and it might help in the advancement of science and general engineering knowledge, if some one would make a series of tests of the capacity of resistance of an audience to mathematical strain, and would tabulate the results, or would plot them in a graphical diagram. The investigation might be conducted somewhat in this way: the investigator would prepare a series of mathematical demonstrations of a progressive character, beginning with examples in the simple rules of arithmetic, and progressing gradually to increasingly difficult problems followed by algebraic formulæ arranged in similar order, which could be succeeded by demonstrations and elucidations in which trigonometry, calculus and other tenacious mathematical methods are employed. The "sums," formulæ and demonstrations to be numbered, and each person in the audience to be provided with a card, and after the mathematical elucidation has been inscribed on a blackboard and explained, each person to mark on his card whether he comprehended the demonstration fully, partially, or not at all. From these cards a series of what may be called moduli of comprehension could be established. That is, they would show how many persons in an audience could understand simple arithmetical proof of any proposition, how many would go wool-gathering over decimal or vulgar fractions, the proportion of people to whom algebra is as Greek is to all who know but one language and are not Grecians. It would, we feel sure, be demonstrated that only an infinitesimal number of persons in audiences, like those which assembled in the hall of the Mechanical Engineers on February 14 and 15, can comprehend an elucidation, in which the processes of calculus are employed, by merely hearing it read. If different scientific organizations would make such tests and establish what might be called *factors of intelligence*, they would be a great help to those who contemplate reading papers before them in determining the limit of elasticity of the audience before which they are to appear. If, for example, it was found that 90 per cent. of the persons who are members of the Society of Mechanical Engineers can understand arithmetical demonstrations, 60 can go as far as easy algebra, 40 per cent. cannot follow in trigonometry, and only 10 can keep up when an author plunges into calculus, then, obviously, the character of his paper should be determined by the number of people he desires to interest and instruct. If it is his purpose to interest his whole audience, he will, if he is wise, do as Professor Sweet did—leave out all mathematics. If he is willing to ignore the 10 per cent. who cannot follow in arithmetic, he may put a few figures in his paper, or he may disregard the 40 per cent. who are "stumped" by algebra and risk a few or many formulæ. This train of reasoning will lead inevitably to the conclusion, that with a given audience a paper may have so much mathematics in it that it would not be worth while to read it at all, because so few or none could understand it. It would be somewhat like the aphorism of the young artist in *Punch*, who painted high-art pictures which no one would buy, and was asked by his uncle why he did not paint popular pictures, like the "Derby Day." The answer was that "art is for the few; the higher the art, the fewer the few; ultimately the highest art is for but *one*, and I am that ONE." There are papers which are evidently written for but one, and that *one* is the author. The question arises whether it is worth while to read such papers. They may have their use and be of very great value, but the reading of them before a miscellaneous audience is probably of no benefit to any one. It is safe to say that there were not three persons in the audience who listened to the paper which was read at the Railroad Club on the evening of February 15, or had the fortitude to hear it all, who could follow the reasoning or the demonstrations which the author had elaborated, evidently with much care and thought. The limit of elasticity of that audience was exceeded, and all who remained through the whole reading of it had a permanent mental "set," and their minds were stretched to such an extent that very few of them reacted when the tension was released. In a recent magazine article the author advises the jocular story-teller, before telling a story, always to calmly put to himself the question, "Should I —— A—— derive pleasure from listening to this from the mouth of B——?" Authors of papers to be read before miscellaneous audiences should always subject themselves to a similar introspection, and should solemnly ask themselves the question, "Would I, the author, be interested or profited from hearing a paper of this kind and length from B—— or any other person of equal caliber to myself?" It might not be a bad plan for committees in charge of such meetings to put some such question to the authors of papers before they are read.

It would, of course, be very great folly, at the present day, for any one to underestimate the uses and value of mathematics as an instrumentality for analysis and investigation. The projector of the North River Tunnel, who testified some years ago before a commission that he thought "a knowledge of mathematics dwarfed a man's mind," has, it is true, a counterpart in a venerable protectionist in Philadelphia, who in a recent public letter expressed the opinion "that of all the institutions in the country, the college was the one which exerted the most pernicious influence."

We all recognize the uses and value of mathematics, the regret of some of us being that we know so little; but a knowledge of it is somewhat like one's underclothing—useful and indispensable, but it is not well to display it publicly.

There are few engineers worthy of the name who would build a bridge, a roof, or construct a machine without taking into account the elastic limit of the material used, and who will yet appear before an assemblage of people without giving a thought to the fact that the attention of those who listen to them is limited by laws as absolute as those which govern the strength and resistance of iron and steel.

Of the value of the paper, whose form, character and length has been commented on, we will for the present at least have nothing to say. Some one has said that they always distrust a conclusion which cannot be proved in any other way excepting by mathematics. There is some reason for this distrust. Whether the conclusions which were reached by Mr. Parke are sound or not will not now be discussed. All that is intended here is to point out that such papers are unsuited for reading before audiences of the kind that assemble at the monthly meetings of the Railroad Club—and perhaps it would not be far wrong to say, or any other audiences—unless it be a very few who are well up in mathematics and are constantly using it. It would seem as though a short catechism might be framed which would be useful to those in charge of and those who intend to read papers or make addresses at technical and other meetings. It might embrace such questions as the following:

Is there a limit within which an audience "may be temporarily acted upon with the certainty of recovering its figure"?

When this limit is "overpassed," what happens?

What proportion of the audience will probably understand and follow an arithmetical demonstration by merely hearing it read? how many can keep up with the algebra in the paper? and can you estimate the percentage of those who will not be vanquished by your calculus?

Estimated in time, when the limit of elasticity of your audience will be reached, when will permanent set begin, how

much extension may be expected, and how much will the area of your audience be reduced before rupture takes place?

In some cases—as in political meetings—it might be well to consider whether the reaction at the point of rupture may not be violent.

It would seem as though a study of the laws of intellectual elasticity would have an analogous result to that which followed a knowledge of the principles of physical elasticity—in the one case mechanical structures were made safer, in the other there would be much less risk that meetings for technical discussion would fail in the purpose for which they are held, which, it may be assumed, is for the entertainment, instruction and profit of those who attend them.

NEW PUBLICATIONS.

HELICAL GEARS. *A Practical Treatise.* By a Foreman Pattern-Maker. Macmillan & Co., New York.

This book gives very clear and detailed directions for the guidance of the pattern-maker in laying out, constructing, and molding helical gears—that is, gears in which the acting surfaces of the teeth, instead of being parallel with the axes of the wheels, as in ordinary spur and bevel gears, are helicoids about these axes. The practical instruction is so explicit, that a pattern-maker, by carefully following it, could produce the best attainable results with very little original thought or invention on his own part. Considerable information is also given as to methods of molding these gears, and altogether the subject is placed in a clearer light, and its possibilities and difficulties more fully explained, than ever before in type.

The author's claims as to the advantages of helical gears, and the more theoretical parts of the book generally, are not quite as happy as those parts relating to the actual making of the patterns. For instance, on page 4, he states that the diagonal thrust, which takes place at all points of contact situated away from the actual pitch point of cycloidal gears, is an evil inseparable from the action of ordinary gears which it is desirable to eliminate. If this is such an evil, why is it that involute teeth, in which this diagonal thrust is always present, even at the pitch point, are being so largely used in the best practice of to day, and are rapidly supplanting the cycloidal shape? Again, the statement that the driving force undergoes constant variation as the point of contact between the teeth moves away from the pitch point is very misleading, as we know that with properly shaped teeth the driving force is constant throughout the whole arc of action. The claim on page 6 that with helical teeth "the wheels would revolve by rolling contact without sliding, and thus approximate to the condition of ideal cylinders rolling by the contact of smooth peripheries," would be rather difficult to sustain.

Helical gears would be used much more generally if they could be made as accurately and as cheaply as ordinary gears, and anything which tends to clear up the mystery surrounding them, or to simplify the methods of making them, or to improve their shapes and accuracy, is very desirable. This book undoubtedly has this tendency, and is a valuable addition to the literature on the subject. It will prove of interest and use to any pattern-maker or draftsman who has much to do with gearing of any description, and should be carefully studied by all who wish to make this kind, or are inclined to the belief that their use would be beneficial or profitable.

HYDRAULIC TESTING-MACHINES. *System of A. H. Emery, C.E.* As Designed and Built by William Sellers & Co. (Incorporated). Philadelphia.

This publication is a pamphlet of 14 pp., 7¼ × 7¼ in., in which the general principles of the Emery testing machine are first described; extracts from reports on the machine made to the Institution of Civil Engineers, the American Association of Mechanical Engineers, and the American Institute of Mining Engineers, are then given. The latter part of the book has the title of "Specification," but it is really a description of the construction of different types which are made by this firm. To those who are interested in the subject of testing machines, and have comparatively little knowledge of them or of the Emery machine, this part of the publication under review will seem quite too brief and lacking in lucidity. It is very doubtful whether any one, even the most skilled mechanic, could get a clear idea of the general construction of the machine from the description given. If one or more sectional drawings had been added, showing its principal parts or organs, with letters of reference, the reader would have had an image of these parts and their relation to each other which would have helped him immensely and enabled him to understand the general construction without difficulty.

The pamphlet before us is illustrated with half-tone engravings of a Hydraulic Support Testing Machine of a capacity of 500,000 lbs., Horizontal Type Machines of 100,000 lbs., 200,000 lbs. and 300,000 lbs. capacity, and a Pump for Testing Machine with Adjustable Stroke.

The following extract will interest the general as well as the technical reader:

"One of the 'proof' experiments by the United States Government Board was the breaking in tension of a forged iron link, 5 in. in diameter between the eyes, at a strain of 722,800 lbs., and immediately thereafter a single horse-hair seven thousandths of an inch in diameter was slowly strained, and after stretching 30 per cent., snapped under the recorded strain of 16 oz. Masses of metal were subjected to pressures of 1,000,000 lbs. in compression alternately with eggs and nutshells, and in all cases the machine operated with equal accuracy."

The typographical work of this catalogue is by the well-known J. B. Lippincott Company, and is all that could be desired.

WHAT AN ENGINEER SHOULD KNOW ABOUT ELECTRICITY. By Albert L. Clough, E.E. The Mason Regulator Company, Boston, Mass. 4¼ × 6¾ in., 108 pp.

The object of this book, the author says in his preface, is "to present plainly and without the use of difficult technicalities or mathematics, to all who have to deal with electrical appliances, brief descriptions of their various forms, practical 'pointers' on the troubles to which they are liable and their remedies, as well as general instructions for doing simple construction work, such as is often needed, as a slight extension of an already established plant."

It begins with some preliminary explanations and definitions about electricity circuits, volts, ampères, ohms, etc. Part I is on Light Current Working, and contains sections on the Battery, Circuits, Electric Bells, Burglar and Fire Alarms, Electric Gas Lighting, Dynamos. Part II is on Heavy Current Applications, and discusses Incandescent Electric Lighting, Arc Lighting, Transmission of Power, Storage Batteries, and ends with the Rules and Requirements of the Underwriters' Association with reference to the use of electric appliances.

The book is written in very simple and clear language, and is full of information for those who have the care of electric appliances. The deficiency in it seems to be that it is assumed that the novice knows more than he really does, and matters which no doubt are extremely plain to the writer are not sufficiently explained. The book is also without an index, which is an unpardonable literary sin.

THE NATIONAL CAR AND LOCOMOTIVE BUILDER. This publication comes to us each month apparently undiminished in prosperity by hard times, and with no loss of interest on account of the dullness in business. The February number contains a number of very interesting articles—one on Passenger Car Construction, by Ernest Merrick, in which some new methods are described, and in which it is proposed to abandon the use of end platforms. Another article is a report on the Best Method of Securing Cylinders, Smoke-Boxes, and Frames on Locomotives, which was made to the Southern & Southwestern Railway Club. Some of the circulars of the Master Car-Builders are reprinted, and much other information is given which will interest those who are concerned in the construction or maintenance of rolling stock. One editorial article, however, is not cheerful reading. It discusses the question, "Where is the safest place on a train?" and points out with considerable minuteness of detail and show of technical knowledge when and where a traveler is most likely to have his neck or his bones broken.

It is announced that the directory of railroads and railroad officers, which is so useful and convenient an appendage to this publication, has been officially corrected, and that the publisher has abandoned machine-set for hand-set type, and prognosticates a generally improved tone in business, for which we are all looking so anxiously. There is a kind of satisfied tone about the publication which implies a comfortable bank account and general prosperity.

Railroad Car Journal. The bound volume of the *Railroad Car Journal* for the year 1893 comprises a very complete record of what has been done in car construction during the past year. While it is almost absolutely impossible, as all railroad men are aware, to obtain matter in regard to the car construction and car designing which bears the stamp of absolute novelty, yet the illustrations and the matter contained in the paper under review constitute a valuable record of current practice and of what has been done in the past. There are numerous working drawings which afford all the information which would be required for a duplication of the original in the shop, as well as photographs of perspective views giving an idea of the external appearance of the cars and car machinery described. The paper is neatly printed, and evidently considerable care is taken in the selection of matter and in the editing of the same, and the whole contains a deal of valuable information for car builders.

An Elementary Treatise on the Steam Engine, *with Questions for Examination*. By Randall W. McDonnell. Dublin: William McGee; London: Marshall & Co. 7¼ × 4¾ in. 48 pp.

The supply and demand for books on the steam-engine seem to be unlimited, and yet an editor of a technical journal is seldom puzzled more than he is when asked to recommend a book on this subject.

The little volume before us, we are informed, is the work of a very young man, who has evidently tried to explain what he has learned from books and other sources, and has done it very well. It begins with an explanation of the old Newcomen's engine and then advances to Watt and to modern practice. It is obviously the work of an amateur author, but is better than many books by writers of more mature years.

Dynamo and Motor Building for Amateurs. By C. D. Parkhurst, U.S.A. The W. J. Johnston Company, Limited, New York. 6¾ × 4¾ in., 163 pp.

This simple book is "an attempt to describe to amateurs such forms and types of motors and dynamos as are simply and easily made." It contains directions for making A Small Electric Motor for Amateurs; A "Home-Made" Electric Motor; A Sewing-Machine Motor for Amateurs; Armature Windings; Connections and Currents; A Fifty-Light Incandescent Dynamo, and an Appendix.

The book is clearly written, with very full and detailed directions for doing what it was the purpose of the author to explain.

TRADE CATALOGUES.

The Lunkenheimer Company, of Cincinnati, have issued a neat folder illustrating their "Renewable Seat-Gate Valves," of which different styles are represented, with a table giving price-list, dimensions, weights, etc.

The Young & Willever Automatic Mechanical Railroad Block-Signal Company, of 204 Walnut Place, Philadelphia, have issued a small—5¼ × 8¼ in.—circular of 8 pp., containing a description of their block signals. It is to be regretted that this description is not accompanied with engravings of their apparatus, as no one can get a clear idea of its construction without such illustrations.

The Detrick & Harvey Machine Company, of Baltimore, send us a neat pocket diary and memorandum book for 1894. It contains some useful data about population and postage and calendars for 1894 and 1895. It also conveys the information—and this is perhaps its most important function—that the publishers are Designers and Builders of Experimental and Special Machinery of all kinds and Manufacturers of the Open Side Planer.

The Magnolia Metal Company, of 74 Cortlandt Street, New York, have published a sheet containing half-tone engravings of 22 different bearings. These apparently are shown as they appeared after being tested, but the whole matter is presented in such an incoherent way, both typographically and rhetorically, that it is not easy to get at the significance of the illustrations or the fragments of reports accompanying them. The purpose of the publication is to show that Magnolia metal came out ahead, in some tests which were made somewhere by somebody, but neither the place where the tests were made nor the parties who made them are clear from the publication before us.

Knowles Special Catalogue of Power Pumps, *for Paper and Pulp Mills*. Knowles Steam Pump Works, 93 Liberty Street, New York. 5¾ × 7¾ in., 31 pp.

The publishers say of this that it is a special catalogue of paper-maker's belt-driven pumps. The following different kinds of pumps are illustrated and described by excellent engravings and clear descriptions: Vertical Triplex Boiler Feed Pump, Horizontal Single Boiler Feed Pump, Horizontal Duplex Light Service Pump, Vertical Triplex Pressure Pump for Hydraulic Pulp Grinders, Horizontal Duplex Pressure Pump for Hydraulic Pulp Grinders, Vertical Post Stuff Pump, Vertical Fly-wheel Stuff Pump, Vertical Fly-wheel Post Stuff Pump, Vertical Duplex Geared Stuff Pump, Triplex Stuff pump, Suction-box Vacuum Pump, Vacuum Pump for Revolving Suction-box, Vacuum Pump for Sulphite Process, Underwriter Fire Pump, Automatic Receiver and Pumps.

The engraving, printing, and descriptions are all excellent.

Ball Balanced Compound Locomotive. 21 pp., 6¼ × 9¼ in. This pamphlet describes a form of locomotive with outside cylinders arranged "tandem" fashion. The centers of the two low-pressure cylinders are sufficiently near together to be connected to crank-pins close to the wheels. The centers of the high-pressure cylinders are farther apart, and they are connected, by separate connecting-rods, to pins on return cranks attached to the main crank-pins. These two pins are set opposite to each other, so that the reciprocating parts of one cylinder balance those of the other. The trailing wheels also have return cranks, and there are two coupling-rods on each side of the engine, which is of the American type.

There are also illustrations of an eight-wheeled suburban locomotive of the Forney type with the balanced compound features adapted to it. These are all very well illustrated, the engravings being made from excellent drawings, but which have been reduced too much, the dimensions being illegible.

The office of the Company is at 82 Church Street, New York.

After the Fair. *Twenty-fifth Anniversary Souvenir of the Page Belting Company*. Concord, N. H. 6¼ × 9¼ in., 36 pp.

The purpose of this pamphlet is to publish the judges' reports and awards which were made to the Page Belting Company, for leather belting exhibited at the Columbian Exhibition, and also to illustrate and describe their exhibits at the great "show." The first few pages are devoted to the awards and reports, and to "Corroboratory Testimony" of those awards. This testimony consists of a series of letters from the parties who used the Page belting at the Exhibition. These are followed by a series of half-tone engravings showing the various exhibits of the Company with descriptions thereof. There is also a history of the Company with a view of their original shops of 1868, and of their present works at Concord, N. H. The last page contains views of their warehouses at 91 Liberty Street, New York; 81 Pearl Street, Boston; 165 Lake Street, Chicago, and 42 Sacramento Street, San Francisco. On the last outside cover is a diagram showing a whole hide of leather, and descriptions of how it is cut to make different kinds of belting.

Wheeler's Improved Surface-Condensers. Wheeler Condenser & Engineering Company, New York. 9¼ × 5¾ in., 20 pp.

The outside cover of this publication has an excellent engraving showing a section of the Wheeler Surface Condenser. It is printed in three colors, the outlines being black; the brass parts are shown in yellow, and the iron or steel parts in blue.

The introductory part of the pamphlet sets forth the "Advantages" of the condenser, and says that when there is a sufficient supply of water available, any existing high-pressure engine can readily be converted into a condensing engine with a resulting economy of from 15 to 25 per cent. of fuel. A description of the construction and operation of the condenser and of the improved "Wheeler Admiralty Tube," which is used, follows. This is succeeded by excellent wood-engravings, showing perspective and sectional views of different

kinds of surface condensers made by this Company. An illustration of a jet condenser, a view of their works at Carteret, N. J., completes this pleasing and satisfactory publication. It may be added that the New York office of the Company is at Nos. 39–41 Cortlandt Street.

HYATT ROLLER BEARING COMPANY. 12 pp., 5¾ × 9 in. Roller bearings have been the subject of the dreams of innumerable inventors for a great many years past. In the pamphlet before us it is said that more than 300 patents have been issued in this country on such bearings, and yet comparatively few are now in use, and those only under slow-moving mechanism. Roller bearings which have heretofore been made had to be turned, hardened and accurately finished. The same is true of ball bearings. The Hyatt bearing is an ingenious device to get over the difficulties encountered in other similar bearings, and consists of *flexible* bearings. They are made of a ribbon or flat bar of steel wound on a mandrel to form a close spiral, and it is claimed that "such a roller adapts itself perfectly to every inequality of the axle or the bearing, and cannot be crushed or distorted by side strains on the bearing or bending of the journal." It is also said that such bearings do not require to be turned or finished in any way, and are therefore much cheaper than any other roller or ball bearings which have heretofore been proposed. The idea is a very ingenious one, and has in it a promise of great success.

Various forms and applications of the bearings are well illustrated and described in the pamphlet which has been issued by the Company, whose office is at 77 Liberty Street, New York.

THE HISTORY OF A LEAD-PENCIL. By Walter Day. The Joseph Dixon Crucible Company, Jersey City, N. J. 6¾ × 5¼ in., 16 pp.

Probably of the millions of people who daily use lead-pencils very few have any idea of how or where they are made. The little publication which the Dixon Crucible Company has just issued gives a great deal of interesting information about the different kinds of pencils which they make, how they are manufactured, and why. The pamphlet is as interesting as a good novel, and probably few who have the time to read it will lay it down without finishing it.

The first part of the description, however, has a sort of strident personal flavor, which may have somewhat the same effect on its readers that those people have who take the liberty of slapping us on the back or punching us with their sticks or umbrellas. The author has taken liberties with the reader which are not entirely agreeable. He begins with the imperious command, printed in caps, "TAKE THAT PENCIL OUT OF YOUR POCKET." It would not be pleasant to have a stranger say that to us, nor is it pleasant to read. The first person singular occurs oftener, too, than is agreeable. Barring these slight lapses of good taste, this little history is very pleasant and profitable reading. It is well illustrated with excellent wood cuts of the mines, mills, and works of the Company, a portrait of its founder, various kinds of pencils made by it, and finally a view on Crystal River, Fla., showing the rafting of cedar logs to the Dixon mill, with a fine alligator in the foreground, who evidently is not happy because he is not provided with a Dixon pencil.

OUR SHARE IN COAST DEFENSE—*Part II.* Builders' Iron Foundry, Providence, R. I. 55 pp., 6 × 9 in.

In the brief preface to this pamphlet the publishers say that, "In publishing the pamphlet 'Our Share in Coast Defense—Part I,' we gave in popular form a rather brief description of the 12-in. Breech-Loading Rifled Mortars and the methods which we employ in their manufacture. We now supplement that pamphlet by reprinting extracts from Government Specifications and Inspectors' Reports, believing that more complete descriptions, exact particulars, and minute details will interest mechanical engineers and others who follow advanced foundry and machine-shop practice."

The frontispiece is a half-tone engraving, showing the 12-in. breech-loading rifled mortars, which was published in THE AMERICAN ENGINEER of last September. This is followed by specifications of their manufacture, with illustrations of the form and position from which test pieces are taken. An outline engraving and outside dimensions and another sectional view of one of the mortars is then given, with specifications governing the finishing and assembling thereof. Other interior views in the foundry are also given, with an outline view of an old style 13-in. seacoast mortar. The metal which is used and the process of manufacture is described, and reports of tests of the materials used are given. A description of the method of operating the breech mechanism, with illustrations of it, completes the work. It is all written in a popular way, and will interest all who are concerned in the subject which it discusses. An omission to be noted is the absence of titles to most of the engravings. A very large proportion of the people into whose hands any book falls never go further than to look it through. To such proper titles to engravings are a great help.

THE CONSOLIDATED CAR-HEATING COMPANY, of Albany, have sent us a poem, by Haines D. Cunningham, "the well-known newspaper correspondent," with the title "The Car-heater and the Traveling Public." We have only room for the following lines, which are submitted as a sample :

"And in daytime, midst his dreaming,
Sits the solitary traveler
Peering through his frosted window,
Out upon the dreary landscape
Drifted high with crystal hillocks,
Sicklied o'er with pale solstitial
Sunlight of the cold north winter,
While his feet are warm, and legs, too,
Dangling limp against the pipe-ways."

The last line of our quotation, it will be seen, does not "even up" quite right. The following amendment is therefore suggested :

"While his feet are warm, and legs, too,
His corns are aching in a tight shoe."

Seriously, we think the Consolidated Car-Heating Company's system of heating is better than Mr. Cunningham's poetry, and, by means of the Sewall Steam Coupler, the lines of pipe on the cars are connected together more satisfactorily than some of the lines of the poetry are. Still, there are some strokes of genius in the poem. For example, the following line addressed to the locomotive :

"In your big, black, bulbous boiler."

In a paragraph from the Manitoba *Free Press* the Consolidated system of steam heating, which has been adopted on the Canadian Pacific Railroad, is commended. We have not received any newspaper clippings commending the poetry

BOOKS RECEIVED.

Bureau of the American Republics. Monthly Bulletin, December, 1893.

The Political Economy of Natural Law. By Henry Wood. Boston : Lee & Shepard.

Sixth Annual Report of the Board of Mediation and Arbitration of the State of New York. Albany : James B. Lyon, State Printer.

Rules for Operation of Steam Heating Systems, Baker Heater, and Pintsch Gas. Published by the Baltimore & Ohio Railroad Company.

Consular Reports. January, 1894 : Commerce, Manufactures, etc. (Packing Goods for Export.) Washington : Government Printing Office.

The National Geographic Magazine, January 31, 1894 : *Proceedings of the International Geographic Conference in Chicago, July* 27, 28, 1893. Washington : Published by the National Geographic Society.

Immigration and Passenger Movement at Ports of the United States during the Year ending June 30, 1893. Report of the Chief of the Bureau of Statistics. Washington : Government Printing Office. 64 pp., 9 × 5¾ in.

The Foreign Commerce and Navigation of the United States for the Year ending June 30, 1893. Prepared by the Chief of the Bureau of Statistics of the Treasury Department. Washington : Government Printing Office. 670 pp., 11½ × 8¼ in.

Engineering Education, being the Proceedings of Section E of the World's Engineering Congress held in Chicago, Ill., July 31 to August 5, 1893. Published by the Society for the Promotion of Engineering Education as Volume I. of their Proceedings. Edited by De Volson Wood, Ira O. Baker,

J. B. Johnson, Committee. Columbia, Mo.: E. W. Stephens, Printer. (This volume is to be had of Professor J. B. Johnson, Secretary, Washington University, St. Louis; $2.50.)

SAVING EFFECTED BY COMPOUND LOCOMOTIVES.

Editor of the American Engineer and Railroad Journal:

Apropos of a recent discussion relative to the merits of the compound locomotive, I am now able, fortunately, to give you some data relative to the action of a compound locomotive on the Chicago, Burlington & Quincy Railroad, which, I think, will be of interest.

The data was gathered, not to determine the merits of the compound locomotive, but because the general officers thought the coal record for a certain month was too high on the division on which the compound was running, so that the report contained the fuel record of the compound. The fuel used by each engine and the number of loaded cars hauled was looked up for each engine. The results are stated in the number of pounds of coal burned in hauling one loaded car 1 mile. The record for the compound was 3.27 lbs. of coal per loaded car mile. The best record for any simple engine of the same class was 3.85 lbs.; for the poorest, 6.32 lbs.; for the average of 40 engines, including the compound, 4.61. So that the saving made by the compound was as follows: Over the best record of any other engine in the same class, 15 per cent.; over the poorest record of a simple engine, 52 per cent.; over the average record of 40 engines of the same class, 29 per cent. As the compound runs in the pool with all the other engines, as the record covers the period of a month, and is almost a duplicate of a similar record made when the engine was new, it seems to me there is no escape from the conclusion that this compound, at least, is saving us at least 25 per cent.

C. H. Quereau,
Engineer of Tests.

MARINE NOTES.

Japanese Torpedo-boats. — Seventeen torpedo-boats are now in course of construction at the navy yard at Kobe, Japan.

The Chinese Navy Worthless.—It is stated at Shanghai, "on excellent authority," that the real reason why none of the Chinese squadron went to Bangkok was that it was found there was not one of the squadron prepared for such a voyage without refitting, the internal condition of the ironclads and cruisers of China's new navy being very imperfect.—*London Daily News.*

The Loss of the "Kearsarge."—The old corvette *Kearsarge*, of the United States Navy, was foundered on Roncador on the night of February 2. She is one of the two vessels, the *Hartford* being the other, which, by special act of Congress, was to have been kept in commission. Her principal victory, for which she is noted, was the destruction of the English-Confederate cruiser *Alabama*, off the coast of France, during our late Civil War.

A Commerce Destroyer.—Sir E. J. Reed, speaking recently at a banquet at Cardiff, said that "he was concerned at the present moment in the construction of a foreign cruiser, a vessel without any armor at all, and without any pretension to be anything but a very fast vessel built for the purpose of causing what mischief she could under certain conditions. He had no hesitation in saying that every one of the guns she carried could penetrate the unarmored ends of 10 of the British line-of battleships, which, being so penetrated, must sink.

The Cruiser "Olympia."—The report of the trial board on the speed of the new cruiser *Olympia*, which was run in the Santa Barbara Channel off the coast of California, gives the vessel a speed of 21.686 knots, which means a premium of $300,000 to the builders. In every point of machinery, speed, H.P., and coal consumption the plans and specifications have been beaten. The required pressure test was 160 lbs., that carried was 166.53; at the starboard engines steam-chest the register was 166.75; at the port engines, 164.83.

The Cruiser "Montgomery."—The trial of the cruiser *Montgomery*, which was held off New London, in Long Island Sound, shows that the vessel developed a speed of 19.056 knots. Her contract called for a speed of 17 knots, and this will mean a bonus of $200,000 to the builders, the Government paying $25,000 for each quarter knot in excess of the contract speed. The average revolution of the port engines during the trial were 180.7, and of the starboard engine 180.3; the average steam pressure 160 lbs. On a requirement of 16,000, the main engine's indicated H.P. was as follows: Starboard, H.P. 2,001; first I.P. 3,097.3; L.P. 3,198.5; total, 8,297.6; port, H.P. 1,903.2; first I.P. 3,185.6; L.P. 3,463.4; total, 8,552.2; grand total for main engines, 16,849.8. The collective H.P. of the main and auxiliary engines operated during the trial amounted to 17,313.08.

It will take from seven to eight months to put the finishing touches on the *Olpmpia* so that she can be declared in commission.

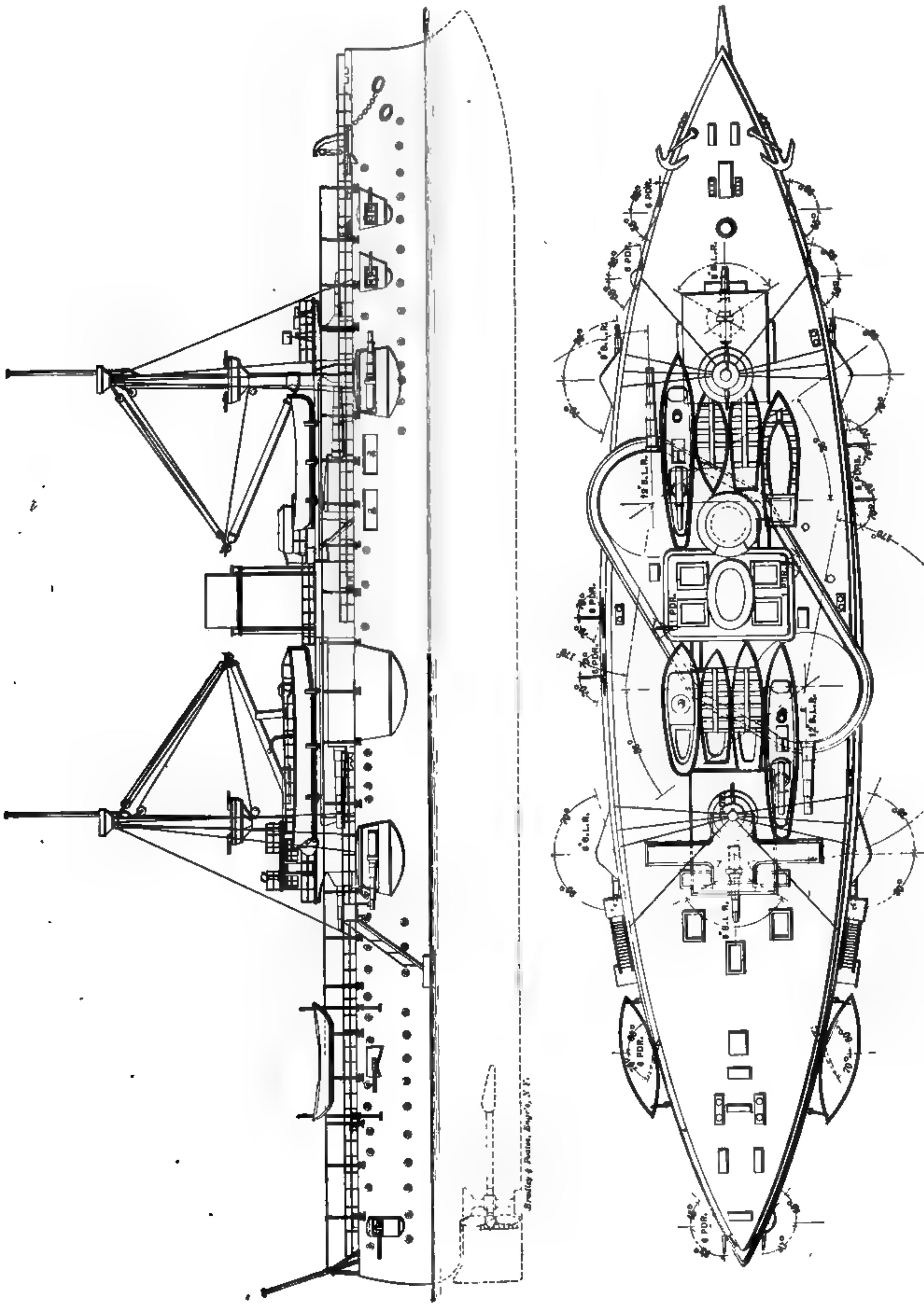
Life-Saving Kites.—We called attention in our issue for September, 1893, to the experiments of Professor G. Woodbridge Davis, in sending a life-line ashore from the Brenton Reef lightship. These experiments have been followed up by others at Sandy Hook, which were equally successful. The kite used is foldable; the sticks are of light ash revolving upon a common center axle, and the frame is covered with oiled muslin. Instead of a single line leading from the face of the kite, two lines are employed, one from either side, and by checking one or the other a trifle after the kite has been raised, it may be directed four compass points or 45° from its direct leeward course, so that it may be landed anywhere within an area of 90°. The value of this steering property may be appreciated when it is explained that it often happens that the only near land to a wrecked vessel is not directly to the leeward, but to the right or left of that point. The principle of the steering action of the kite is based upon that of the fore-and-aft sail, which may be trimmed to a certain limit without spilling the wind. As soon as the kite is raised and the guy-lines adjusted so that it is directed aright, these are secured to a wooden float or buoy, and the latter is thrown overboard, having to it a light but strong line which is paid out as the kite flies to the land, dragging the buoy through the water. When the float reaches the beach the life-saving crew detach it and bend on to the ship's rope the regular lines and blocks, which the wrecked seamen haul out to their vessel and make secure, according to the directions found painted on the small wooden tags fastened to the blocks. The crew are then brought to land either in the breeches-buoy or life-car hauled out to them by the life-saving crew.

THE BATTLESHIP "TEXAS."

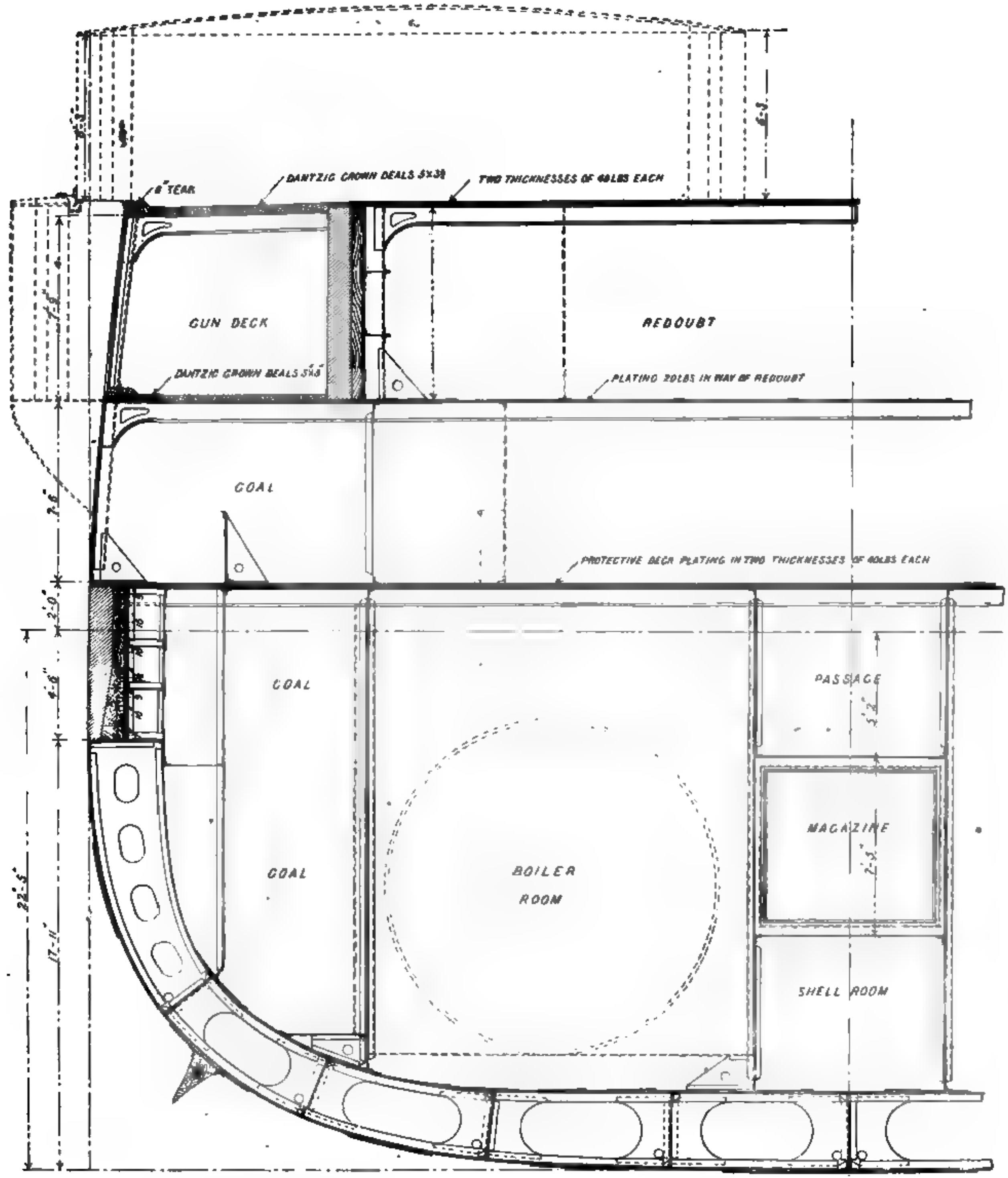
The battleship *Texas*, which is now nearing completion at the United States Navy Yard, at Norfolk, Va., will be one of the most powerful battleships of the new Navy. It is a twin-screw vessel of the belted type, built after the designs of the Barrows Ship Building Company. It has a belt of armor admidships to protect the vital portions of the ship, as well as under-water decks from the ends of the armor to the extremities of the vessel. Her dimensions are: Length between perpendiculars, 290 ft.; extreme breadth, 64 ft. 1 in.; molded depth to upper deck, 39 ft. 8 in.; draft of water forward, 22 ft.; draft of water aft, 25 ft. 5 in.; giving a mean draft of 22 ft. 6 in. The displacement when brought down to this draft is 6,300 tons, and the transverse meta-center of gravity is calculated at 3 ft. 1¾ in. The longitudinal meta-center above the center of gravity is estimated at 237 ft. When being loaded the vessel drops 1 in. for each additional 30 tons, and the moment required to change the trim 1 in. in 1 ft. is 432 tons.

The engines, which we will illustrate in a later issue, were built by the Richmond Locomotive Works, at Richmond, Va., from designs approved by the Navy Department, and have an indicated H.P. of 8,600. As the vessel is intended purely as a fighting machine, no attempt has been made to give her the excessive speed which has been attained by the cruisers *Columbia* and *New York;* therefore her maximum speed is 17 knots, and she will be given a complement of 300 officers and men.

Referring to our cross-sectional engraving, the vertical keel is made of steel 20 lbs. to the square foot, and reduced to 11½ lbs. at the ends. It is 39 in. deep amidships, with double angles at the tube of 3½ × 3 in., weighing 8 lbs. to the foot. The outer flat keel weighs 25 lbs. per square foot, and the inner 17½ lbs. to the square foot. From the fourth longitudinal to the armament shelf, the outer and inner angles are 3½ × 3 in. with a plate between lightened with holes. The frames both before and abaft the armor both consist of Z bars 6 × 3½ × 3 in., weighing 15 lbs. to the foot, with the lower ends where they come down on the armor deck secured by 15-lb. plates,



SIDE ELEVATION AND DECK-PLAN OF UNITED STATES BATTLESHIP "TEXAS."



HALF CROSS-SECTION OF THE UNITED STATES BATTLESHIP TEXAS.

and they are split where coming down to the keel with a 10-lb. floor-plate riveted in. The bottom plating is 17½ lbs. per square foot, and runs up to the armor deck and protective deck; above this it weighs only 15 lbs., but is increased to 60 lbs. in the wake of the machine guns. The inner bottom is 10 lbs. per square foot. The vessel has two masts, each with military tops. The vital portions of the vessel are protected by a steel armor belt 12 in. thick, and rising 2 ft. above the water-line, and extending 4½ ft. below it. At a point 18½ in. below the water-line the armor belt begins to narrow down until it is 6 in. thick at the bottom, or 4½ ft. below the water-line. This armor belt protection extends over the engines, boilers, and magazines, and terminates at each end in a steel breastwork 6 in. thick extending diagonally across the vessel. The backing is of wood 6 in. thick at the top and vertical at the back, so that at the bottom it is 12 in. thick widening out on the bevel, which has already been referred to in the armor. Back of the wood packing are two thicknesses of 25 lb. plating. The shelf plate for the armor weighs 25 lbs., and back of this plating and behind the packing are two horizontal girders formed of 15 in. plating secured to the plating behind the packing by 3½ × 3-in. angles. The armored protective deck is worked down over the armor, both sloping slightly down from the ends of the vessel to the bow and the stern. This deck is 3 in. thick throughout. The lower parts of the turret and the machinery for working the guns are encased in armored redoubts 12 in. thick and backed by 6 in. of wood. These turrets are plated with 12-in. armor. There is also an armored conning tower 12 in thick placed forward on a level with the bridge with an armor tube leading from it 3 in. thick. The ammunition masts are 6 in. thickness. In our next issue we will publish a detailed description of the sections of this turret, with the hydraulic operating mechanism used for handling it and the guns, which was, together with the engines already referred to, designed and built at the shops of the Richmond Locomotive Works.

The armament consists of a main battery of two 12-in. guns in turrets and six 6-in. guns protected by shields. The 12-in. guns will be mounted in turrets placed *en échelon*, so as to give a fore-and-aft fire. These turrets are further encased in the diagonal redoubt, which is heavily armored and extends diagonally across the vessel from one turret to the other, as shown on the plan. Each turret has a complete broadside fire on one side, and has a train on the opposite side 40° for the forward gun and 70° for the aft. A 6-in. gun is placed forward and on about the same level as the 12-in. gun, each having a train of 120°. The remaining four 6-in. guns are mounted in sponsons on the main deck, two having a train directly forward to 25° abaft the beam, and two directly aft. These are also clearly shown on the plan engraving. On the main deck the secondary battery consists of four 6-pdrs., four 3-pdrs., and four 47 mm revolving cannon, each of which is protected by 1½ in. steel plating. Two Gatling guns and two 37 mm. revolving cannon are located on the bridge deck, and two 1-pdrs. are placed on the firing bridge. Two Gatling guns with 47 mm. revolving cannon are to be fought from the military mast tops to repel boarders and torpedo-boat attacks. Two 37 mm. rapid-fire guns are fitted in the steam cutters. The magazine for the main battery is placed in the center of the vessel below the protective deck. The ammunition for the secondary battery is stowed in magazines located forward and aft, the ammunition being passed up to the main deck through an armor tube 3 in. thick. Torpedoes can be projected through six tubes, one through the bow, one through the stern, two through the side aft above water, and two through the side forward below water.

In reference to the motive power, as we intend publishing in a later issue detailed drawings of the engines, we will simply state here that it consists of two triple-expansion engines placed in separate water-tight compartments. The water-tight compartments here run longitudinally through the length of the boiler and engine space, or equivalent to the length of the armor plate. Aft and forward of these points the vessel is divided by transverse bulkheads only, the longitudinal bulkheads stopping at this point. The cylinders and engines are 36, 51, and 78 in. in diameter, with a stroke of 39 in. There are four double-ended boilers 14 ft. diameter × 17 ft. long, the steam pressure being 150 lbs. The grate-area is 504 sq. ft. As the engines are to be run at all times under an air pressure, the maximum of which is 2 in. of water, the indicated H.P. will be 8,600. Five hundred tons of coal can be stowed, and this is calculated to give an endurance at a speed of 17 knots of 1,110 nautical miles; at 15 knots, an endurance of 2,050; and at 12 knots will be 3,170 nautical miles. With a coal supply of 850 tons the endurance is, for a speed of 16½ knots, 2,180 miles; at 14.75 knots, 3,900 miles; 11.8 knots, 6,000 miles.

The vessel is to be fitted as a flag-ship. Directly aft on the gun deck there will be a private cabin for the admiral, and forward of this will be his dining-room and sleeping-cabin. Next will be the admiral's bath, closet, and pantry. Forward of these there are similar accommodations for the captain. Forward of this, extending across the vessel, is an open space with two passages leading forward from it. These passages enclose the ward-room, and the state-rooms open into them from the sides. There are nine state-rooms opening into these passages. Beyond the ward-room bulkhead there is a large open space which can be used by the steerage officers. The crew are berthed forward on the gun and berth decks.

At a recent visit to the vessel she was lying tied to the wharf at Norfolk, with her machinery in position. Nearly everything in connection with the engineering department is already located, and the delay now is waiting for the armor. It is expected that this will be delivered early this month and that it will be in position, so that the sea trials can take place in June. The armor is being manufactured by the Bethlehem Iron Works, at South Bethlehem, Pa.

MEETING OF MEMBERS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The second meeting of members of this Society, for the discussion of technical subjects, was held in the hall of the Society, at No. 12 West Thirty-first Street, on Wednesday evening, February 14. The subject which was discussed at the January meeting—"The Development of Stationary Engines, as illustrated by those exhibited at the Columbian Exhibition in Chicago"—was continued at the last one. Professor John E. Sweet, of Syracuse, N. Y., read the opening address, to which he gave the title

PRIMING,

probably because it was intended as a stimulus to the members in attendance to shoot their guns off in the subsequent discussion. Professor Sweet said:

Mr. Chairman and Fellow-Members:

If I rightly caliper the aim the promoters of this monthly meeting scheme had in view in selecting some one member to open the discussion, it was with a view of having that individual discuss something of interest, or say something that shall inspire others to discuss it; and the object of the discussion is for the exchange of thought, the advancement of our engineering knowledge and practice, or the heralding of our mechanical achievements as a sort of mutual admiration society in disguise.

From all that was said about the modern steam-engine at the previous meeting, there is but little left of interest for me to say, and my only hope lies in saying something that will strike flashes of inspiration from others. There are two ways to promote discussion: one to say something the listeners like to hear, whereat many are ready to add their hearty endorsement, and the other to say what they do not like to hear, which will bring up as many to refute the assertions.

Assuming that you will all agree that the latter plan is likely to make things more lively, your committee may well congratulate themselves in having selected for this purpose one whose proverbial modesty entitles him to the privilege of ridiculing the past, finding fault with the present, and criticising the future; besides abusing the fraternity in general.

In considering the present, let us review the past; and trusting you will allow me, I will go back to the first step in the stairway of my interest in steam engineering, the Exhibition of the Royal Agricultural Society, at Battersey Park, in London, 1862, or 31 years before the Columbian Exhibition at Chicago.

I remembered that there was a lot of portable engines there, and so turned back to some printed letters written home at that time, and find this paragraph: "But one still greater feature than all was the almost incredible number of portable steam-engines—83 different ones—all with steam up and going at the same time and driving threshing machines, straw cutters, grist-mills, tile and brick machines, etc. Six or seven were traction engines."

To this I might add something about steam plowing, which was then and still is successfully practised in England, and the steam road rollers, which were common; but I do not call up this subject to show how we outstrip all other nations (in following in their foot-steps), but to call attention to this branch of steam engineering (which has not been thus far considered) and to describe one of the many things I saw at Chicago which excited my liveliest admiration.

A traction engine of not the largest size, built somewhere in Ohio, well invented, not very well designed, frivolous in some of its details, and deplorable in workmanship, was harnessed to a 5-ton load of pig iron piled on a stone boat. The engine hauled that around over the dry ground with as much indifference as if it had been so many pigs of pork. It went down into the canal, wallowed around like a sea-lion, and out up a bank where one would not expect to see a team draw up a wagon. It was driven up to a railroad track where the ties had been blocked up until the top of the rails were 2 ft. above the level. The engine mounted this obstruction diagonally, first one forward wheel, then the other; then alternately the back wheels in like manner, running along over the ties and turning off diagonally as it had mounted—in fact, performing the feat precisely as an elephant would have done, and with like ease and indifference.

I was so astounded at this exhibition, so elated to see the justifiable pride shine out of the builder's countenance, that I did not stop to consider then, as I hesitate to question now, whether it would not have been better to build the engine with less of the spirit of a gymnast and more in line of durability in its legitimate work. Allowing the thing to be worth doing, the man who did it is never likely to receive half the credit he deserves. When the means are compared with the end, the builders of stationary engines and locomotives may take off their hats to the builders of traction engines, and call them brothers.

As the Cornish pumping engine set the pace in steam economy for half a century, so the Cardiff trial of portable engines 20 years ago set the mark so high that small engines of no kind have as yet in this country approached it. Compound portables have long been common in England, though they have not yet appeared here.

To go back to the same year 1862, the year of the second London Exhibition, my memory does not even picture the steam-engine exhibit, but I remember Mr. Porter exhibited a rapid-running engine, and patented, introduced and promoted the manufacture of the Richards indicator.

The next step on the exhibition ladder was the Paris Exposition of 1867. At that exhibition two engines of mark beyond all others set their hands upon the industrial world, and have held them there for a generation—the Corliss engine from the parent works at Providence, and the Porter-Allen, built by Whitworth. While the Porter-Allen was admired and the makers' name demanded respect, it was too novel, untried, or for some reason did not take root in Europe. The Corliss engine, new to the Continent, was admired for its silver jacket, polished bonnets and general trousseau, ridiculed for its complexity, but understood by the leading engineers of Europe. Although Mr. Corliss had no Continental patents, it was taken up by three or four of the leading manufacturers, and royalties paid the same as if he had held patents—honorable deeds certainly; and if they have been reciprocated in like manner to the least extent, the fact is not generally known. In plain English, if any American has paid a foreigner royalty on an unpatented invention, some of his friends should make it known.

While the natural sons of neither of these engines (the Corliss and the Porter-Allen) were shown at Chicago, what Chordal designated the Hyphen-Corliss and what may be styled the Fitzporter engines were too numerous to escape attention—in fact, they constituted the bulk of that wonderful collection in Machinery Hall. It may be true, and likely is, that there were high-speed engines built before the Porter-Allen engine, but it is one that still lives, and I fancy one that has suffered least by changes and modifications, certainly least of any in looks; it is the respected parent of a numerous group of sons and daughters-in-law that I shall speak of later.

Mounting the third step of our experience, the Centennial. While compound engines were quite common in Europe and on the sea, and Adamson had, I think, built his quadruple, none were shown at Philadelphia—in fact, our own engineers did not believe in them. Although the single-cylinder engine has been transformed into many shapes, it had then reached a pretty high state of completeness; the Buckeye, the only engine shown at both Chicago and Philadelphia, and the Corliss had reached the forms they followed for many years. The Corliss centerpiece, with its two single cylinders, walking-beam and 30-ft. gear, was one of the grandest steam-engine monuments in its impressiveness ever erected; but judged in the light of the present practice showed (as Mr. Porter pointed out at the time) just how not to do it. In explanation of this statement, it may be well to give the substance of a friendly criticism of the great Corliss triumph, held under its own shadow. It was, as you all remember, a beam-engine with two 40-in. cylinders, 10 ft. stroke, two walking-beams coupled to the two cranks of a shaft carrying a 30-ft. gear working into a pinion some 12 ft. in diameter, the engine making from 35 to 38 turns, and the second shaft about 90. By what process of reasoning our conclusions were arrived at I do not now remember, but it was agreed that two 40-in. cylinders at 4 ft stroke directly connected to the second shaft and run at the same piston speed would accomplish the result at an immensely less expense. The whole Chicago display shows that is what would now be done; and while Mr. Hemenway allows there has been a gain in pumping engines of only 20 to 25 per cent., I am sure the Allis Chicago engine will harvest 2 H.P. from the sowing of the same amount of coal that it would take to get one from the Corliss Centennial; which, as it was specially suited to compounding, and yet was not compound, shows that Mr. Corliss at that time had not been convinced that there was enough advantage to go to that slight additional expense.

I am well aware that it is almost sacrilegious to criticise the design of that wonderful Centennial monument, but shall do so in the belief that the very audacity of the thing will emphasize the point I wish to make. The design was in two distinct styles intermingled, just the wrong thing to do as well in machinery as in building. The framing was of the most severe straight lines, almost seeming to be simply a reproduction in iron of its wood prototype, while the beams were in graceful curves and the lever-arms of the valve motions not curves, but crooked and freely graceful. Milan Cathedral and the Corliss engine are noble examples of mixed architecture, but noble in spite of the mixture and not because of it.

When one sets himself the task of looking into this feature of machine design, he will find in it one of the explanations of why things do not look right. There is an engine of recent production where the arms of the wheels are elliptical, a conspicuous lever I-section, rocker-arms round, cylinder-head one style and steam-chest covers another, and yet there seems no apparent reason why, if the machine was consistently designed, it would not accomplish the work just as well as it does now. I am well aware of the danger one encounters in criticising designs, and to simply say one looks well and another not, without giving the reason, is setting one man's opinion against another; but certainly there is such a thing as consistency, which plainly is subject to demonstration.

Builders of the modern improved Jones, Smith & Brown Corliss engines found themselves confronted by this condition. Steam pressure had gone from 60 to 120 lbs., and something had to be done to meet the new conditions. Three methods were open to them: put in more iron, put it in a better form, or make more attachments to the foundation. As is usual with improvers, the most of them take the wrong road. Hicks & Hargraves, of Bolton, England, adopted the right plan on the start, by making the frame a complete box. The only Hyphen Corliss engine exhibited at Paris in 1867 was of this make and this form. At Chicago two of the Corliss type claimed to be box section, but the builders spent some money to spoil them by cutting ornamental holes through their vital parts.

A round column (not more than 24 diameters in length) cannot be improved, except by putting more metal in it. In any other form it can be by making it round. A round tube is not a suitable form for an engine bed, a rectangular one is, and is nearly as strong as a round one. Aside from the push and pull, the strain on a Corliss bed is a torsional one. A rectangular box will resist this strain about 16 times better than an I-beam of the same cross section. Against a push-and-pull strain a crooked element is a weak one. If it must be crooked, a box section is best able to resist it; but why crooked? There is plenty of room around a Corliss engine to make a bed straight and have it right, and when it is right it will look right, provided the designer has the ability and the observer the right training. This in no way means that everything should be straight, for as often, perhaps more often, the thing to be right has to be the furthest possible from that, and the one who makes the thing straight that should be crooked makes a worse blunder than the other.

As mentioned before, if there are two roads for an imitator to take to improve an original design, he will take the wrong one; so, too, if there is any one feature that is bad or less meritorious than another, he is sure to stick to that with a persistency worthy of the best, and mutilate the subtle beauties he cannot appreciate; and this confirms me in the notion I have always entertained, that the overhanging cylinder of the Porter-Allen engine is not right.

Of the dozen or two of engine builders, both those who allow that their engine beds are of the Porter-Allen type, and those who build the same thing without the allowance, adhere persistently to the overhanging cylinder, and remodel the graceful contour of the bed (which has never been equalled) with a freedom wonderful to behold.

They not only hang to the overhanging cylinder, but hang on another one, in looking at which I can only think of an

old man turning his back to the job, catching his boy and holding him out at arm's length, and the two working away with the old man's posterior as the business end of the combination. Some of them, fearing the boy will get tired, put a crutch under his back.

In the most recent developments of the man-and-boy scheme, as it appears to me, the old man sits down on the foundation and takes the boy in his lap; each, however, true to his association, holds to the overhanging cylinder.

I do not underestimate the animosity I am likely to excite by criticising designs, and offer the following in justification—not in justification as to the right and wrong of my opinions, but in justification of doing the thing at all. We all of us talk about each other's plans, whether cross, compound, tandem, quarter cut-off, clearance, horizontal, upright, Corliss, Willans, Sulzer, triple-expansion, or valve-gear and all the rest of it, without any feeling in the matter whatever, and steam engineering has been immensely benefited by it.

Artists, the most jealous of all people excepting musicians, criticise each other's work and submit to the irrevocable decision of a hanging committee, and how are we to improve our designs better than to submit to the condemnation of our bad work by others and applaud the good in theirs? It seems as if the question of whether cabinet work is an appropriate adjunct to a steam-engine or not could have but one answer, and still it goes on, and I really suppose it looks nice to most people when new and horrid to everybody ever after.

It would seem, after the example set by the Reynolds-Corliss, the Buckeye, and the German engines at Chicago, that we would soon see the last of it, and this leads me to the final step, the Columbian Exposition.

Through the kindness of the various builders I have been able to get a pretty accurate statement of the number, size, kind and power of the various engines of about from 100 H.P. and upward. The list does not comprise the small engines, of which, perhaps, there was 150 H.P. all told, nor does it include pumping, air-compressing, gas-engines, portable or semi-portable, of which no guess even has been made.

There were 29 single-cylinder engines aggregating 4,820 H.P., 47 compound engines aggregating 24,930 H.P., 5 triple-expansion engines aggregating 3,925 H.P., and 1 quadruple engine of 3,000 H.P., making in all 82 engines of a total of 36,675 H.P., exceeding the *Campania* by 7,000 H.P., making it likely the greatest aggregation of steam power ever assembled in so small a space.

Comparing the work of the present with that of 17 years ago, the Centennial with the Columbian, Chicago with Philadelphia, so far as the use of the steam-engine is considered, it is a change from single-cylinder to compound, triple, and quadruple-expansion, and the generation and development of the single balance valve, shaft governor, high-speed engine. But so far as the production of steam from the combustion of coal, the best of to-day is but little better if any than the best of 1876, nor is the average to any great extent better than then. Boilers have been improved, so that higher pressures are as safe to-day as the lower pressures, were before, and as more power is obtainable from high pressures than from low, to this extent has the modern boiler contributed its share to the improved economy. Water-tube boilers were wholly employed at Chicago, but that is no gauge as to what is the practice of the country, and only indicates the tendency which points as much toward higher pressures as it does toward the water-tube varieties, and the water-tube is gaining because of its ability to carry the high pressures.

An incredible amount of work has been expended on boiler and engine-room auxiliaries, some of unquestionable and much of questionable merit. Nothing has come to supersede the Worthington duplex steam pump, as its many copies confirm, wasteful as it is said to be in steam economy, and the various forms of steam injectors are mostly modifications of the original, and they hold about the same relation to the steam pump as they have for years. There are many new and many modifications of both single-acting and duplex pumps, and many modifications of the injector, mostly double, using the principle of the inspirator; but the main improvements have been in the simplifying of the number of handles to be operated, and in the devices that make the injector self-starting. Economy in the use of steam, either in the steam pump or injector, does not appear to have made much headway. At least, the more economical have not swept the old aside to such an extent as the automatic engine has superseded the slide-valve throttling sort.

Boiler feed-heaters have taken on new forms, with likely constructive and possibly with operative advantages, but with little strikingly new in principle, otherwise than where heaters and filters are so combined as to better rid the feed-water of its impurities before entering the boilers. Treating the water with chemicals and filtering is probably the most recent and advanced change that has been made.

Various new boiler compounds have been compounded, but what advance if any has been made is in a wider understanding, that the remedy must fit the disease. Just so far as compounds or filters prevent incrustation or contribute to keeping the boilers clean, just so much they have contributed to economy, and if all fixtures are credited with the saving claimed, they far more than make up for the increased boiler efficiency; so that boiler-makers may be falling back rather than progressing in the economy of steam production, though that is not likely.

Automatic damper regulators, high and low-water alarms, sediment pans, automatic boiler feeders, improved grate-bars, mechanical stokers, various steam and oil separators, and the steam loop have been studied over, changed, improved, perfected, or invented and applied during recent years; and these, too, in their way have contributed to steam economy, but in none has the change been more marked or results so advantageous as in the engines themselves.

Considering the engine exhibits at Chicago in the order of their magnitude, the 7,700 H.P. of Westinghouse, Church, Kerr & Co. was so far beyond anything ever before shown by one exhibitor as to set aside comparison. Their standard and compound engines, which have been on the market for a decade, call for no comment except that inspired by the wonderful growth of the industry. To install an experimental engine at an exhibition is a very risky thing to do; to install six experimental 1,000 H.P. engines of entirely new design, embracing untried mechanical devices, was a courageous one, and one that entitles the Company to as liberal consideration as the result requires to make the account stand on the creditable side. The new feature of air-spring to balance the weight of valve mechanism and at the same time to serve as starting-bar was as good a scheme as the many other good schemes shown by other builders.

The 3,000 quadruple Allis was too large for my comprehension, and I only raise the question whether the addition of the new feature to prolong the cut-off, and thus increase the range of power, is the best way to accomplish the result.

The Willans experiments tend to show, so far as an experiment with his style and that size engine can determine, that the superiority of automatic cut-off over throttling is less conspicuous on a compound than a single cylinder, and shows that there is very little or no economy at all in a triple-expansion. If this applies to all multiple-cylinder engines, then it may be possible that it is the best plan to reduce the valve-motion to the simple elements and govern by a throttling governor. If this will hold good in the case of the Allis engine, of course the same points come up in the Buckeye, Frazer & Chalmers, and others showing novel motions whose aim is in the same direction.

There is a more or less tendency to mix the shaft governor and Corliss valve, as shown by three or four different examples, the aim being to retain the good points of the Corliss valve and be able to run at higher speed. A promising scheme.

One word about the Bates drop motion. If it is as good as the detachable arrangement, then they can pride themselves on having something of their own; and while it does not place them above the first step on the Corliss monument, it puts them one step above those who only follow the original. I cannot follow out the list, noting every improvement each engine builder claimed; many good, perhaps one as good as another, and all worthy of a more extended notice than I am able to give them.

Among the marked novelties in engines—I mean a complete engine—that by Lavals, of Sweden, was one of the most conspicuous. Being myself the grand-nephew of a rotary engine, and this being a rotary engine, I speak as a relative, and venture to predict that, notwithstanding the 10,000 American patented rotary engines, this little Swedish bumble-bee of a thing is nearer seeing the daylight of success than any other before exhibited. While it employs the principle of a Pelton water-wheel, it possesses just those additional elements not in the Pelton wheel that make it a promising advance.

The Willans engine, while nearly as old as many well known American engines, is new to us and remarkable in many respects, but particularly for its economy in spite of what we have supposed to be detrimental features—throttling, single-acting, mechanically fitted valves, and high speed. But these defects, whether imaginary or real, are overcome or neutralized, and other advantages come in naturally, so that, while at first sight the claims for its economy are questioned, there is a lot of genuine steam engineering in it. Besides the low clearance, free escape for water, and no loss from compression, the main thing lies, I believe, in the fact that the steam end of

neither cylinder is ever in communication with the one of lower pressure or with the condenser. I spoke of the enormous growth of the Westinghouse; that of the Willans has been phenomenal—20,000 H.P. last year. We are prone to joke over the slow, conservative English; but perhaps they know a good thing when they see it, after all.

For great power in small space, the claim we make for our high-speed engines, it seems to me about an even send-off between the Westinghouse, Willans, and that crowning feature of the engine display, the triple-expansion 1,200 H.P. in the German exhibit. Personally I have not much to say about this engine, though I went by it several times a day for three months. It was never my good fortune to be there when they were making repairs, and so I could see no more than other visitors. Another engine of like power and occupying much more space and far more pretentious seemed to be in a chronic state of repair mostly.

Of all that was said at the previous meeting, nothing pleased me more than Mr. Holloway's remarks about the Creusot engine. It was not only by far the best piece of machine work I ever saw, but up to the present time I believe it would be utterly impossible to produce the like in this country, and for the same reason that we could not produce work like the "Venus de Medici" or Raphael's "Transfiguration."

As shown by the exhibits at Chicago, the standing appears in this way: The largest and most economical, and probably as economical as has been thus far built, was the Allis engine; the largest exhibit by any one firm was that of the Westinghouse, both American; the most economical high-speed engine the Willans, English; the best piece of steam engineering, the German; the best rotary, Swedish; and the best workmanship, French.

As to the future, I think we may look forward to using better judgment as to putting the right engine in the right place. There is a right and wrong place, if not for all, at least for several kinds. The claims against the high speed are that it is not economical, and terribly prone to smash-ups—claims pretty well founded; but, in spite of that, it has built itself up and was the means of building up the largest half of the electric-light business. As to its wasteful use of steam, that has been overestimated and is fast being improved; and as to the smash-ups, better separators and safety devices and the destructive fly-wheel accidents of the last two years of slow-speed engines put the boot on the other foot. With the high-speed engine and Mr. Porter came better work, and much better yet is needed and will be demanded, for there is a place for the high-speed simple engine that nothing else can fill. There is, too, a place for the Corliss engine and a place for the compound, though already many of them have been put in the wrong place; there is a place, and as yet a good deal of unoccupied space, for a vertical, direct connected machine, and places for the triple and quadruple-expansion. There is a show for better designs, a show for better workmanship, especially in castings; and as to the show for improvement in steam engineering, I can only reply, as Barnum did when asked what he thought his chances were for heaven. He said, "he thought he had the greatest show on earth."

DISCUSSION.

Mr. Cartwright: There is one feature Professor Sweet has spoken of which I heartily agree with. I am not connected with any engine works, but I have to use engines for different purposes, and when he says you may have the right engine in the wrong place, I think he says a great deal. That certainly has been my experience. My board of directors oftentimes say, "Why, Mr. Cartwright, you certainly will put in a Corliss engine." "No, gentlemen, I would not have a Corliss engine in that place. A Corliss engine is good where you are running 26 hours out of the 24 for the year right along, but I would not put a Corliss engine in where I was using it intermittently." I have one engine that in two years never has turned over but one-half day, but she did turn over when the call was made on her. A Corliss engine would not do that, according to my experience. You cannot lay up a Corliss engine as easily as you can lay up some others. I put in a Green engine. The professor did not bring in the Green engine, I believe, in enumerating the engines he spoke of. I think it is a very good engine. Mr. Sweet was at Chicago three months. I was going to say I was there three days, and of course I could not see as much as he did, but I did take off my hat to the German engine. I think it was the only engine on the ground there that was a first-class engine. When I asked these different parties why this was, they would say: "I will tell you, Mr. Cartwright. The foundation is so poor here that you cannot get in any engines." But you saw that German engine working there, and she did her work perfectly. I never saw a better exhibition of an engine in operation than she was, and I admired her thoroughly.

In relation to the big Corliss engine at the Centennial, it was a good monument. It was a very pretty picture, but it had a great many defects, as we afterward learned. They had two beautiful staircases up to the beam. Those staircases were not in the original design of the engine, as I understand it, but they were put up there to hold her up. They were put there as side-braces to take the lateral motion. The Buckeye took my attention at the Centennial.

Now I have just installed a plant for 4,000 H.P. I put in a Woodbury balanced slide-valve engine, and am perfectly satisfied with it—167 revolutions out of a 500-horse engine, and she does work magnificently. She will be an intermittent engine, because when we have no water we will call on the steam. We may have it for a year, and we may not have it for three months.

My experience with the Corliss engine is that it needs the doctor very often. We have handled a good many of them. The vibrating valve wears off. A Corliss engine cannot be repaired by any machine shop; it may be done, but special machinery is better. Take a Green engine, for instance; we have there all the advantages of the drop cut-off and the plain slide-valve. Mr. Le Van and I were boys together, and we did not have any machinery, and we took a hammer and chisel to do our repairs; but with a Corliss engine you have got to have special machinery to repair it properly.

Mr. Emery: By going off into a corner of the grounds, into the station of the Intramural Railroad, you would find a 170 kilowatt generator run by the Williams engine, a unique engine all the way through. It was of the marine engine type, but it was handling a generator very much heavier than the old-fashioned engine, and it would stand right up to its work, running 2,500 ampères, 560 volts there, slowing up when necessary, because it was not large enough to carry it, and then rising up to speed again. It ran the road without assistance from any other engine. It was a very creditable performance, and those who did not happen to see it missed something.

I was particularly impressed with the large number of engines with single-valves, regulated by the governor, compounds and single engines, all working well. The high-speed engines had their troubles at first, and they were largely due to bad work. They were due to bad governing, and between the two there were considerable breakdowns, and there were hot bearings, and they were not popular; but those engines worked well, and a great many of them were fully loaded.

Mr. Odell: In regard to the Corliss engine at the Centennial, it probably was not of the best design, and it has been a subject of ridicule. But about that time, from 1872 to 1876, it was my good fortune to be very intimately acquainted with George H. Corliss. I did a great deal of testing for him, and those who know Corliss well, know that he always had some object in view in designing an engine. He designed that Corliss engine as an exhibition engine, and while he was building that engine he was designing an engine which has given about as good duty as anything from that day to this. I refer to the Pawtucket pumping engine.

Mr. Kent: The lesson of the engineering exhibit at Chicago to me was one of chaos. Steam engineering is undoubtedly undergoing a transition, and we do not know what it is going to eventuate in. There is a conflict between half-a-dozen types, and in each type there are half-a-dozen varieties. It looks as if in the next few years many of the engine builders of the country would be called on to revolutionize their shops and build a different kind of engine from what they are now building. We have heard encomiums of the high-speed small engine, running very high speeds and small powers. It looks as if the epitaph of that engine was very shortly to be written, because it has absolutely failed to demonstrate economy of steam. The slow-speed engines of the Corliss type are likely to be driven out to a large extent by the marine type of engine, and it is a question whether that is the coming type. There have been a great many criticisms made of the marine type of engine—that is, the three cylinders, cranks at 120, vertical engine—on account of its supposed instability vertically, the vibrations, the difficulty of climbing up-stairs to oil the engine, and all these things. Williams's exhibit also shows that there may be a change, and certainly makes the fly-wheel governor men a little alarmed by bringing back the possibilities of throttling governing again. Have we been making a mistake in saying that the throttling governor engine was a thing of the past? Shall we have to say that it is fully as automatic as the other when we put it on three cylinders?

Mr. Durfee: It may be of interest to the engineers present to know that prior to 1870 there were some Corliss vertical tandem engines designed by Mr. Griffin, and erected in the

Phœnix Iron Works. Those engines are still running, I believe. There was quite an interval of time between their erection and starting, through some change in the business, but the engines have given good satisfaction from the time they were put to work until the present. In 1861 I put a Corliss vertical engine, 42 × 42, running 85 revolutions a minute, in the North Chicago Mill. That engine I subsequently took out and put into the Milwaukee Mill in 1868. That engine is still running the rail train in the Milwaukee Mill. The last time I saw it it was making 85 revolutions a minute. I have never heard of any undue expense for repairs on that engine.

In about 1864 there was put into the Park Brothers' steel works—the Black Diamond Steel Works—several Corliss engines. One of them was of the same size and made from the same pattern that I used at the North Chicago Mill—42 × 42, upright. That drove a large plate train. I think it is still at work there.

As regards the Centennial engine, it may be of interest to hear the criticism of an English engineer on that engine. In 1885 I went to Chicago to attend a meeting of the Mining Engineers, I think it was, and with the party was Mr. John Jeers, of Middlesborough, England. I spent considerable time with him, and we went to Pullman with the rest of the party. Going into the engine-room Mr. Jeers was leaning on my arm. He never had seen this large engine, and really it looked about four times as large as it did at the Centennial. He held me back a moment and stopped and looked at that engine and said: "Mr. Durfee, that is the grandest engine I ever saw in all my life!"

Professor Hutton: What Mr. Kent says induces me to reminiscence and to confirmation of his feeling of uncertainty. In 1879 I was called on, as a sort of advisory engineer at Columbia College, to recommend to the Board of Trustees what form of engine we should put in to drive the ventilating fan of the building, which was then under construction. It was obvious that we wanted to have a high-speed engine, and Professor Trowbridge and myself agreed that the only engine that would meet the requirements of the case was the Porter-Allen engine, and there were several years during which all our class-room work was directed in that way. Mr. Porter could not furnish us with the engine when we wanted it, and the contractors went to the only other high speed engine that there was in existence at that time, and that was the Buckeye. That was only three years after the Centennial—by the time it was put in it was four years—and at that time there were but two high-speed engines; and when Professor Sweet was asked to give the opening paper at the formation of the Society, it was considered that it would be of great interest to have him describe to the American Society of Mechanical Engineers, just then formed, the special features of construction of his straight-line engine. That was a distinct novelty when this Society was formed only 14 years ago. When we consider that all this development of the modern engine, as we have seen it in Chicago, is the development of the last few years, we can appreciate how everlastingly rapid the development has been during that short time, and can concede that Mr. Kent's criticism is perhaps deserved, that we do not know exactly what is the future and stable type of the steam-engine.

I, personally, was very much struck with the remark made by Mr. George S. Strong at our meeting a month ago. Of course Mr. Strong spoke as a locomotive engineer, but he made this point: "Why in the world are the stationary engineers putting in power plants, proceeding on a very extravagant basis, which would strike a locomotive engineer as so very much beyond what is at all required?" That there is no reason in the world why one boiler should not be able to furnish the 1,400 H.P. that the locomotive is continuously able to deliver, and that from that one boiler and two cylinders we should be able to get upward of 1,000 H.P. for perhaps very little over $12,000. There is no one who does not talk of an electric light plant for $10,000, without at once thinking that means a good many boilers of the water-tube or other type and a very expensive engine, which in itself goes very near that sum of $10,000; and certainly we have, every time a 1,000 H.P. plant is designed, a figure that has much transcended the cost of a locomotive. If it be so, that the marine engine is a solution on land of the problem in that form, I think that there is a good deal for the engineer to learn in the direction of making a power plant of considerable magnitude for a little money.

Mr. Durfee: I remember seeing some years ago an engraving of a type of engine that is said to be quite common in England. I do not think it has ever been undertaken here. It is practically a semi-portable engine. There is a bed-plate of cast iron on which is mounted a locomotive boiler, a saddle under the smoke-stack end, and on each side of the saddle is a steam cylinder. The crank is just back of the smoke-box, and there are one or more fly-wheels on the outside of this bed-plate. The arrangement is as near as possible like that of the locomotive. I have been told that those engines are quite popular with those who have purchased them in England. The engine is capable of concentrating a very large amount of power in a very small space.

There was one remark more that I intended to make in regard to the Corliss engine, and that was in respect to the excellent work turned out under Mr. Corliss's administration. When I took this 42-in. cylinder engine from Chicago to Milwaukee I found that it was necessary to replace the dash-pots. They had got broken. I sent to Mr. Corliss for some castings, telling him that I would finish them at our works. To my surprise, the dash-pots came completely finished. Even the bolt-holes, 2-in. × 2¼, reamed bolts, were bored. The lugs for bolting them on to the frame were all planed off. I put some men to work on Sunday to put those dash-pots in position, and to my surprise when we got the stems of the dash-pots where they belonged, the planed finish of this lug was in contact with the corresponding part on the face of the engine, and I drove those bolts through with a mallet myself, screwed them up, and that was all there was to do to it. It is more remarkable when we consider that that engine was the first engine that Mr. Corliss had made off of those patterns.

Mr. Loring: Professor Hutton's quotation of Mr. Strong in reference to the use of the locomotive boiler and engine on land will recall to you, Mr. Chairman, perhaps, a little of the conversation that we had to-day, in which you confirmed the statement which I had made, that the locomotive boiler as built for locomotives has always been a failure when it has been attempted to use it on land or at sea. No man, I think, would be wild enough to propose to put a locomotive boiler, as it is constructed for railroad purposes, in use either for shop work or for the sea. There seems to be something in the peculiarity of the service to which the locomotive is put which enables it to do things which in the quiet of a shop or in the gentle motion of the sea makes it impossible to do. It is necessary, as you all know, either for land purposes or for sea purposes, to provide some method by which the ascending and the descending currents can be established, and by which the steam can escape readily from the tubes. This ability to disengage the steam at least is probably brought about by the vibrations of the locomotive upon the rails, by which the bubble of steam is detached immediately it is made. There have been repeated efforts to apply the locomotive boiler to marine purposes, with tubes far better arranged for circulation than they are ordinarily in the locomotive, and they have always been failures if they approximate at all the nature of the locomotive. I think there is no builder here who would dare to put the moderate quantity of bearing surface in the crank-pin that the locomotive carries. Whether it is the constant motion of the crank-pin in the open air that keeps it cool or not, I am not prepared to say; but those proportions would not do for a steamer, nor would they do on land.

In reference to the antiquity of certain engines which my friend, who has delved in antiquities, has mentioned to-night, I know of an engine that was completed during my apprenticeship. It was somewhere near 1848. That engine is still running in the American Tube Works, working their mandrels on the draw-bench, and what was known in those days as the grasshopper-engine—that is, it had a beam supported on one end of a vibrating beam, the crank being between this upright beam and the cylinder, and the rectitude of the piston-rod was controlled by a parallel motion. That engine, built in 1848 or 1849, is still running in the tool works, and without any material repair and no alteration whatever.

Mr. Durfee: Talking about antiquities, there was an engine put into the Baldwin Locomotive Works in 1836. It was put into those works by my father, and it was designed by Mr. Baldwin. Mr. Baldwin had a peculiar idea in regard to a stationary engine. He said that a stationary engine was not correct if the cylinder was horizontal; neither was it correct if the cylinder was vertical. His view was that the engine ought to be placed accurately at an angle of 45°, the main shaft being in the air and the cylinders down at the bottom of the inclined plane. Consequently this engine was put up in that way. A large brick foundation was built up the main shaft near the ceiling of the room, and the cylinder at the lower end. Another peculiar idea that Mr. Baldwin had was that the hexagonal guide-bar of all engines should be utilized as a feed-pump, and therefore the hexagonal guide-bar of that engine was made a hollow, and the plunger worked in the ends of it, which worked by an arm extending from the cross-head of the engine. The lower end of the bar had the usual valves. The last time I saw that engine, a few years ago, that pump was still working, feeding the boilers. The older members here will recollect that the early Baldwin locomo-

tives had similar feed-pumps and similar prismatic guide-bars.

Mr. Platt: Professor Sweet spoke of being at Battersea at the exposition of the Royal Agricultural Society of England. Agricultural engineering owes very much to that Society for the judicious way in which it has given prizes for excellence in agricultural engineering. Every few years they give prizes for certain branches, more particularly steam-engines, and the engineers had such confidence in the experts employed by the Society to conduct the trials, that they devoted themselves very thoroughly to producing the best things they could, and the result was that they raised agricultural engineering to the very highest point of engineering science. That has fallen into disuse somewhat, and many of the large makers are resting on their laurels; but now and again they give prizes, and it brings to the front some of the younger engineers; and notably at the last competition it brought to the front many new men who have since reaped the advantage of these trials.

Professor Sweet referred to steam plowing. That is still carried on to a very considerable extent in our country. Parties get engines and let them out to hire, or rather plow the land at so much per acre for farmers, and considerable business is done in that way.

Some one has referred to the locomotive boiler not being more generally used in stationary work. Well, some of you know that Mr. E. D. Leavitt used the locomotive type of boiler very much for some of his work; but you will bear in mind that it is usually continuous work—that is, they work day and night, and that is one great advantage in locomotive boilers, to keep the boiler always at work. That is the difference between the American and the English locomotive. You can use steel fire-box plates in America, and we cannot use them in England, because you run your locomotives day and night with two sets of men, and ours are only run days. They go into sheds at night and cool down, and I think that is one great reason why steel boxes won't stand with us, and another reason is that our boilers are more rigid. They are stronger and better stayed and not so elastic as the American build of boiler.

Some one remarked as to using the marine type of engine more extensively for land purposes. There has been a tendency in that direction in England. Many large factory engines have been erected of that type, some of them running very considerable piston speeds, but they do not run so comfortably as the horizontal engines of longer strokes. There is a good deal of trouble with the packing boxes. The grit and dirt work down into the gland, and that, I believe, is the principal trouble they find in England. Hick Hargraves have erected some very fine examples, but still they stick more generally to their horizontal compound type and are making some very large powers.

Mr. Le Van: I had the pleasure on Monday of looking at an engine built in 1819. The engine had run up to 1885, and it was only superseded on account of being too small. It was a low pressure engine.

Mr. Kent: It strikes me as singular that so young a man as I am can go beyond Mr. Le Van and Mr. Durfee, but in *Engineering News* you will see a drawing of an engine running in Savannah, Ga., built in 1815 by Bolton & Watt, imported from England. It is really a remarkable engine. It is 30 ft. long on a horizontal line, 6-ft. cylinder, 31 in. diameter, beam about 18 ft. long, and running, I think, 18 revolutions a minute with 8 lbs. pressure, and developing 90 H.P.

Mr. Cartwright: I happened to be engineer of an establishment that had one of old Oliver Ames's engines, and I saw her running. It was built 1808. I have said before, and have been laughed at, that the modern engine as built to-day has more good machinery that is spoiled by being over-fitted than all that has been under-fitted. I had an engine some eight or 10 years ago—a Corliss engine—and she was a splendid piece of work. I had charge of the establishment for some three months. One day I came over to New York, and the whole establishment was stopped. The engine had melted the babbitt out of the bearings. I said I could fix her, but the president would not let me. He sent to Mr. Harris, who sent his Mr. Babbitt down, who agreed with me, but said that Mr. Harris is a stickler for fine fits. Periodically she melted her babbitt out. She did it once when I was alone and I fixed her, so that she has been running nine years and has not stopped since. All I did was to take one-tenth of an inch off her crank-shaft. Now that character of work spoils more work than all this loose fitting does. I want to have a fit, but I do not want to pinch things. I have seen traveling cranes built that developed more power to turn them over when they had a load on than the whole thing would run with if she had a chance to go and come. I will show you to-day drawings of a man-of-war that was built in 1848. She had a trunk engine. Now no one would think about making a trunk engine to-day; but it was good in its place. You had to get all the machinery below the water-line. We had not got on to those back action grasshoppers that we had during the war. Why is it that after we put the marine engine on board a ship that we have to make her so excessively heavy? The reason is that she is bearing here one instant and there the next. Look at the big crank-shafts, how easily they are broken! It is because of the undulations. It is just like bending a piece of tin. You take a stationary engine, put it on a good foundation, and with good care of the engineer it ought to run forever.

Dr. Emery: The remarks of Professor Hutton make it appear to me very proper to mention the originator of the high-speed engine with a single valve. I refer to our late lamented associate, John C. Hoadley. I think any one who will go over the facts will realize that such is the case. We had the hog motion, as it was called, the sliding of the eccentric across the shaft, long before his time, and it was therefore known that that was applicable; but the first instance that I recollect of an engine that worked properly, that was the prototype of the present high-speed engine, was exhibited by John C. Hoadley at the Centennial Exposition. He was building a line of portable engines with locomotive boilers and the engine of that type mounted upon it. He had there the present modern spring governor, well proportioned to give good regulation, and he had the piston-valve, and in a test of that engine it ran down to 26 lbs. to the H.P., high pressure, non-condensing, or below the tests I have made of engines developing the same power of the Corliss type. That was in 1876. Many may not know that his draftsmen were Armington & Sims, and that their work followed his. He got into financial difficulties, and they took the shop. I think, however, that their work did not come out until after the Buckeye mentioned by Professor Hutton. In the Centennial report you will find the success of that engine recorded, and I think to him should be given that credit.

Mr. Platt: I do not know whether it is over-fitting or what that we have to look to, but certainly I was surprised at the number of hot bearings and breakdowns that took place at the Chicago Exposition. From the first right through to the end we were continually seeing engines of one kind and another stopped; bearings hot, cylinder heads blown out, and one thing and another was constantly going on. It was something that ought not to have been seen in an exposition of that kind. Just where the reason is I do not know. I was in Hicks & Hargraves' place in England a year or two ago, and they had then six or seven large engines, up to 2,000 or 3,000 H.P., vertical. I noticed that they paid great attention to the crank-shaft bearings. They were all made a big swivel bearing. They used also a great deal of steel in the framing. But I know that they considered that a good deal of trouble had taken place in those big engines with the crank-shaft and crank-shaft bearing, and they had designed this bearing to get over the difficulty. They seemed to have great success with the engine, and I know of building a number of them for electric-lighting purposes. We were speaking of the questions of bearings heating and the question of end play. Now the firms in the north there always allow one-eighth of an inch, and even more than that, end play in the main bearing and the crank-shaft bearings, too, and they never get hot while they wear forever. I know engines that have been put up inside of two or three days at a big mill and started up, and then they will go on working, and perhaps it will be six months before the engine stops.

Mr. Bitts: In regard to old engines, I am rather surprised that no one has referred to an engine that was shown in 1876. The first engine which was ever put to work in this country was a pumping engine, which was at the Schuyler copper mines at Arlington, and parts of which exist, I think, at this day, and were until very recently to be seen at Newark.

Mr. Forney: I have listened to the discussion this evening with a great deal of interest, and it happens to me, as it happens to most other people, that I am very apt to look at subjects through the spectacles I am in the habit of wearing. For a good many years I have been in the habit of looking at steam-engines only as they are applied to locomotive purposes. There has been a good deal said this evening about the defects and the deficiencies of stationary engines, which somehow seemed to me to have been solved to a considerable extent in locomotive engines. We have heard this evening about the high-speed engine, which was introduced, I believe, in the first place, at the Centennial. It seems to me if we refer to locomotive practice we will find that high-speed engines were used as locomotives a great while before the Centennial Exposition. I think we might go back even to the time of the *Rocket*, and find that that was a high-speed engine. So that,

as far as the problem of high speed is concerned, it strikes me that it was solved in locomotive practice long before 1876.

Now there are a good many other problems which come up to locomotive men. It is not only a question of high speed, but it is also a question of slow speed. Such engines must be built to work at the very slowest speed at the maximum capacity that it is possible for them to exert, and then gradually increase the rate of work and the amount of power developed, until you reach speeds of 60, 70—some men are sanguine enough to say 80 miles an hour. Such conditions are very different from the conditions under which a stationary engine or even an ordinary marine engine must work. The power developed in a locomotive boiler differs immensely from that developed in a stationary or marine boiler. Some experiments made on the Baltimore & Ohio Railroad, on the heavy grade over the Allegheny Mountains, showed that they burned 196 lbs. of coal per square foot of grate per hour. As there are about 20 sq. ft. of grate on an ordinary locomotive boiler, that means they burned about 4,000 lbs. of coal per hour; and as they would evaporate about 6 lbs. of water, it is not a difficult matter to get at the amount of work done by that locomotive in that period. Some tests show that they have burned over 200 lbs. of coal per square foot of grate per hour. I think it would be very difficult to find any other type of boiler which does a corresponding amount of work.

Commodore Loring this evening has told us that no one would dare to place a locomotive boiler either in a ship or in a stationary engine and expect it to do the great amount of work done in locomotive practice, and apparently he attributed that difference in the operation of the locomotive boiler to the fact that it is working under a certain amount of tremor during the whole period of its active exertion. It seems to me that if that is the fact, if the difference in the working of a locomotive is attributable to that fact, it would be a wise thing to apply a sort of Swedish movement cure to a locomotive boiler, and keep it in a constant state of tremor while at work. The secret of that, it strikes me, must be somewhere else. At any rate, it is worthy of very careful investigation to see how much the superior efficiency of locomotive boilers is due to that tremor or the roughness of the track.

You have also, no doubt, heard a great deal about the difficulty they are having in the English Navy in keeping tubes tight. I have asked the question a good many times as to whether in marine boilers they use copper ferrules on the ends of their tubes, and I find that practice is not at all general. In locomotive practice it is almost universal now to fit the firebox end of the tubes with a copper ferrule on the outside of the tube, between it and the tube-sheet, and then caulk it up over that. I think no locomotive man who understands his business would dare to put steel or iron tubes into a locomotive without putting in a copper ferrule.

Furthermore, we have heard that locomotive crank-pins are made of such a size, that no one would dare to imitate that practice in a marine or stationary engine, and that fact is attributed to the circumstance that the locomotive crank-pin is revolving at a very high rate of speed in the open air, and is thus cooled down in the current of air to which it is exposed. If that is true, it strikes me as a very simple expedient to put on a blower and blow on to the crank-pins and keep them cool. Another gentleman has spoken of the difficulty of keeping the shafts of marine engines in a state of integrity. We find the locomotives running at these high rates of speed over tracks of every degree of roughness and of smoothness, running by day and by night, in the cold and in the wet, and still our shafts are not constantly breaking. Then another gentleman has said this evening that a great deal of difficulty arises from the fact that we have too much good fitting; that our engines are built too well; that we do not allow end play. Now those bad things seem to exist in locomotive practice. If we do not allow end play, the working of the locomotive very soon provides it for itself, and our great trouble is to keep them from having end play. It, therefore, would be perhaps advisable to shake up ordinary stationary engines and marine engines, so that they would give more of this end play that is so desirable. I think there are a good many things worked out in locomotive practice which it might be well to look into, and find out just what the principles are which enable us to do things in locomotive work which cannot be done in stationary and in marine work.

Mr. Cartwright: In regard to copper ferrules for a marine boiler, we all know what salt water does with copper in a boiler. It will cut the iron very quickly.

The Chairman: The subject of the next meeting will be Testing Machines and Tests of Materials, and an introductory address will be given by Mr. J. Sellers Bancroft of William Sellers & Co., of Philadelphia, describing the recent improvement in the Emery system of testing machines.

APPARATUS FOR RAPID LOADING OF COAL INTO SHIPS.

By G. Braet.

(Continued from page 119.)

Lifts of the Bruay Mining Company, Calais.—This company has its loading basin located at the north of Bethune, and is in communication with the canal of Abie a la Basse. The loading wharf has a railroad communication with the mines; it is provided with two hydraulic lifts located at a fixed distance from each other, so as to be able to place a boat that is to be loaded under the hoppers of each of the apparatuses. The hydraulic lift is composed of a platform placed central with the railroad which runs parallel to the wharf. The cross-bars of iron at the ends of the platform are turned up vertically and serve to support the two trunnions which are carried by cast-iron supports. The upper part of these vertical portions are provided with an endless screw, which is used to draw in or set out the two blocks which serve to hold the body of the car during its period of inclination. Below the platform there is an ordinary hydraulic lift, which receives its water from an accumulator. The piston of this hydraulic press is connected to the platform by means of two intermediate connecting-rods.

The hopper which is used to carry the coal from the car into the boat is trapezoidal in form. The longest side is equal to the length of the body of the car, and the opposite end on the basin side is narrow, so that it can enter the end openings of the boats of average capacity. The end of this hopper or shute has a special arrangement which permits it to hold the coal in the shute and to distribute it at all points along the boat. The handling of this end of the hopper is done by means of a crab with an endless screw. The upper part of the hopper is formed of a movable table pivoted on the vertical supports of the platform, and which rest on the hopper, properly speaking. This movable table follows the motion of the platform. The hopper is carried by a shaft resting on two blocks fastened to the wall of the wharf; by means of the crab K it can be moved horizontally for the purpose of accommodating it to the easy handling of the boats. This crab also serves to regulate the inclination of the hopper so that the coal will slide over it freely.

The apparatus is worked in this way: An ordinary car full of coal having been run on the platform, as shown in the figure, the blocks are brought out against the side of the body, and then the side doors of the car are opened; at the same time a cock is opened which admits the liquid from the accumulator into the hydraulic ram. As soon as the cock is opened the platform and the car rise, turning about the trunnions; the doors of the car, which are swung from the upper portion of the body, swing out naturally as the car is inclined, and the coal runs slowly into the hopper, whence it falls into the boat at a slow speed. The raising of the car is then continued until the floor has an inclination of about 32°, which is sufficient to cause the coal to run out. When the car has been completely emptied the platform is dropped back again and another run upon it. The body of the car consists of a single box which has a capacity of 10 tons.

With a single apparatus of this kind the Bruay Company unloads about 70 cars a day. The greatest rapidity which has thus far been obtained is five cars in ten minutes. Such an apparatus will cost about $2,100.

The Coal-Handling Frame of the Noeux Company (Pl. VII).—The tracks of the coaling station are connected with the unloading wharf which is built along the docks of the company, that are also connected with the Canal of La Bassée à Aire. The fixed hopper is composed of a structure formed of two ribbed cast-iron cheeks solidly bolted to the wall of the wharf and carrying on their upper end a crab for handling the movable shute. The bottom of the hopper is made of plate iron, and stands at an angle of about 24°. The movable shute is connected with the fixed hopper by a neck or distributor which can be put in any position about a vertical axis, and which thus serves to distribute the coal over the whole of the circumference which is thus described. The chains which carry the end of the shute run over sheaves, and then come down to be wound up on drums of the crab. In order to balance the weight of the whole the two drums are keyed to the same arbor on the crab and are provided with chains which carry counterweights traveling up and down in the vertical wells which are built into the wall of the wharf. In order to reduce the weight of the moving parts as much as possible and to guarantee their strength and durability, the shute and distributor have been made of sheet steel, and the gearing, the

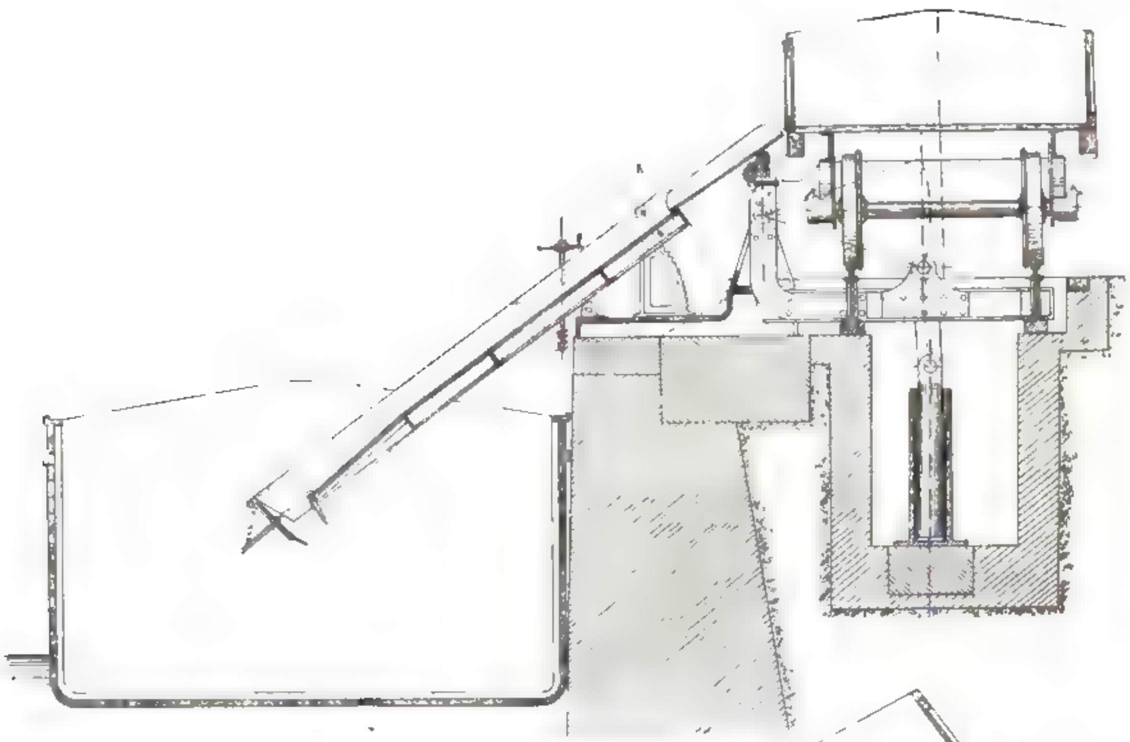


Fig 9

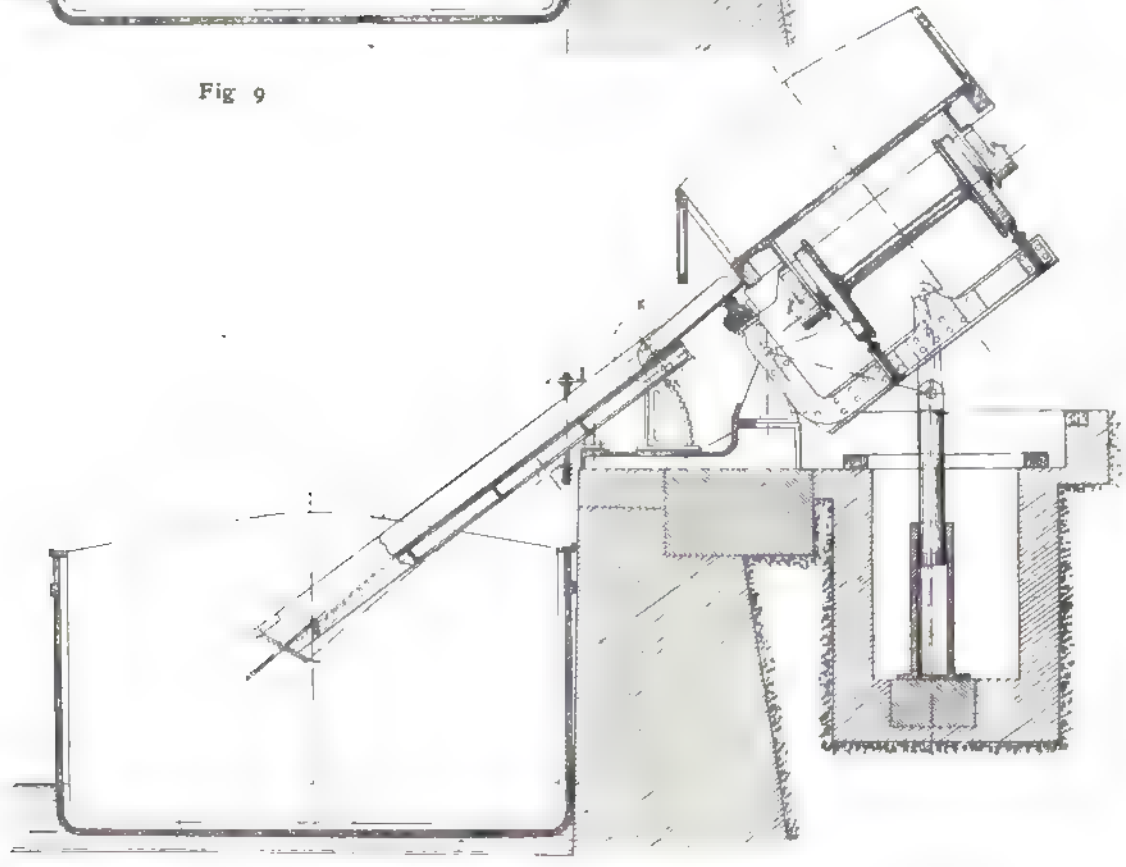


Fig. 10.

LIFT OF THE BRUAY MINING COMPANY, CALAIS, FRANCE.

bevelled pinions, and the sheaves of cast or forged copper. The rotating movement of the neck is obtained in the following manner: The neck has a toothed cap which meshes in with a bevelled pinion keyed on the same shaft as the wheel, and driven by an endless chain. This crown gear is guided by sheaves carried on a circular and grooved piece bolted to the rounded end of the shute. In order to handle the apparatus the workman takes the wheel of the crab in his hand and thus raises or lowers the shute and turns the distributor by means of the endless chain. The inclination of the shute can be varied from 20° to 32°.

The cars are made entirely of iron. The excess of weight is compensated for by the greater durability and strength of form over that obtained in wooden cars. Each car is composed of a truck carrying three boxes of sheet metal strengthened by angle irons and other special forms. Each box has a capacity of $3\frac{1}{2}$ tons. They have two strong hinges, about which they can turn and be given such an inclination as is desirable on the

longitudinal sills. On the sides standing next the hopper the box is closed by a door pivoted horizontally and engaging in clips which are fastened a little back and upon the ends of the car. At the bottom of this door two pins are fastened which work laterally and are caught when the box rests on the truck by two dogs attached to the sill.

In this way an automatic opening, which is very reliable and very simple, is obtained. When the box is raised at the back it turns about the hinges, and the pins on the door are gradually set free from their dogs, and at a given moment the opening is completely free for the passage of the coal. If, on the other hand, the box is empty and it has dropped back on the track, the pins catch under their dogs before this operation is completed in consequence of an eccentricity which is given to the pivots about which the door swings, so that the latter is tightly closed when the box has come back to its normal position for transportation. At the Noeux Station the boxes are raised by means of a hydraulic ram which moves in a cylinder

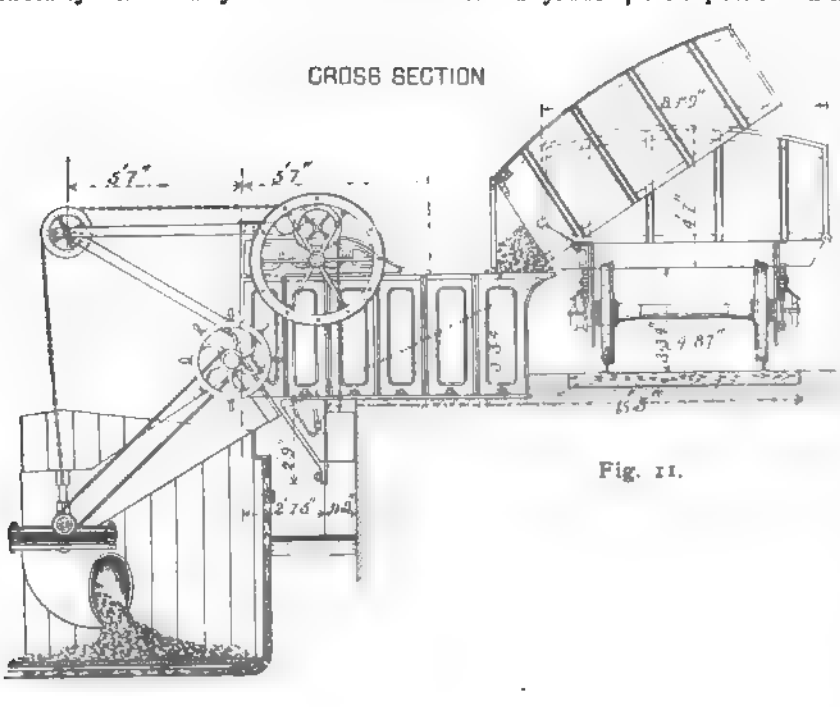


Fig. 11.

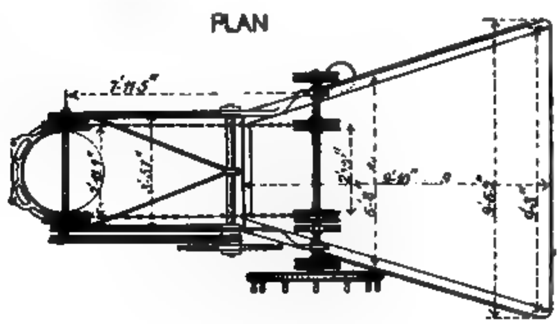


Fig. 12.

COAL-HANDLING FRAME OF THE NOEUX COMPANY.

oscillating about two trunnions; the water under a pressure from an accumulator is let into this cylinder by a cock. Some engineers prefer the oscillating method to a fixed method as being more simple and transmitting more useful power without the use of connecting rods. At the loading wharf the boxes are raised by an ordinary crane.

In Germany, in the basin of the Ruhr, especially at Ruhrort, there are some tilting arrangements which tilt by weights, and which work very well. But we prefer tumblers delivering coal on one side, as they require less attention to haul the wagons in and remove them again. In other respects these tilting cars are of a construction similar to that which we have just been speaking about, and are handled in the same way, hence we will not stop to discuss them further at this point.

At Seraing and Yemeppe, in Belgium, there is a tumbler of the same kind as that which we have just spoken about, but whose working is not entirely satisfactory, and leaves something to be desired. As we have seen, there is no agreement as yet as to the best method of loading coal, but when we have given the situation, the amount of traffic, the kind of coal, and other matters which are to be loaded, the type of the rolling ing stock and the motive power at our disposal, we can then make a choice of the best system to adopt.

EXPERIMENTS ON THE EXPANSION OF LOCOMOTIVE FIRE-BOXES.

In 1892 some experiments were undertaken at the Batignolles shops of the Western Railway Company of France, for the purpose of determining the kind and importance of the relative expansion which takes place in different parts of the fire-box of a locomotive boiler while it is under pressure. An attempt was made at the same time to determine whether the method of supporting the fire-box, which had been adopted for the new high-speed engines of the Western Railway Company, would lend itself readily to the movements of these expansions, and especially maintain itself in a firm position during all the normal conditions of running. The bracing which is referred to consists of a system of transverse bars attached to the fire-box by screws, and resting freely at their ends on horizontal brackets riveted to the outside of the shell, as shown in fig. 1. When the fire is first lighted the fire-box, which is of copper, expands slightly under the direct action of the flames, while the outer shell, which is of iron and which is only heated slowly and follows the variations of the temperature of the mass of the water, expands very little and very much more slowly. The fire-box thus first rises relatively to the outer shell. It is very important, then, that this rising can be made freely, for every resistance which tends to oppose it strains the tube sheet and tends to make the holes oval. In the system of bracing which is indicated the crossbars are not fastened to the brackets, and can thus easily rise from them without in any way interfering with the movement of the crown sheet. But it is also of equal importance that the fire-box should not run suspended in this way when it is in service, for if it should the running vibrations would strain the stay bolts very greatly, and the continuous shaking which would result would soon cause cracks or even breakages in these stay-bolts. It is, therefore, very essential in fire-boxes under consideration that the cross stays should rest firmly on their brackets before the standard pressure is reached, and that in the limits between which the pressure varies in services the contact shall remain established, guaranteeing the rigidity of the fire-box while running. Both of the experiments undertaken were to determine whether this condition had been entirely fulfilled.

The boiler with which the experiment was made was removed from the frames, and the mud-ring rested at its center point upon foundation which was absolutely rigid. The shell of the boiler was also held at the front end, and as a displacement of the fire-box would have falsified the results of the experiments, a greased sheet was placed under the smoke-box to facilitate the movements of the expansion which might be caused at the front end.

The vertical expansions of the fire-box were measured directly in the following manner: Two steel rods were screwed into the top of the crown bars at the extreme front and back end of the fire-boxes, as shown in fig. 2, and their upper extremities came out of the shell through stuffing-boxes. Fig. 3 gives a detail of this arrangement. At the top of the boiler and near the end of the rods two horizontal scales were fastened independently of the boiler. The variations in the posi-

tions of the end of the rods, and consequently of the fire-box, were thus traced on these scales by means of a gauge point. By setting two gauges into prick punch marks $L\ L'$, which were made in the outer shell of the fire-box near each of the two gauge-rods already referred to, the variations in the position of the outer shell could be traced on the same scale. This arrangement permitted the simultaneous measurement at any point in the experiment of the vertical expansions of the fire-box and its outer shell, and to follow their relative movements. In addition, the expansions of the outer shell were measured while steam was being raised in a vertical and transverse direction. The vertical expansions were measured in two planes

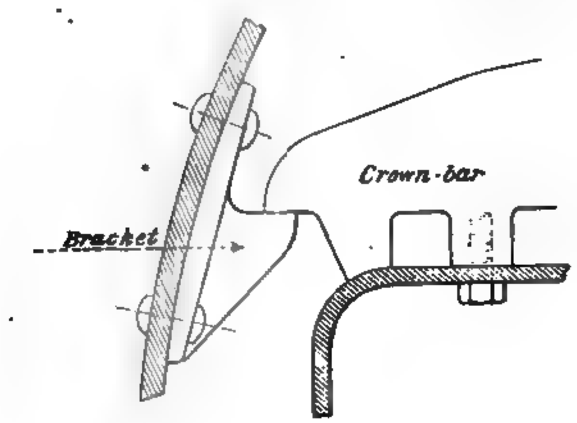


Fig. 1.

S and S', fig. 2, perpendicular to the axis of the boiler and passing through the axis of the rods attached to the crown bars. The intersections of these planes with the external surface of the fire-box was also traced. Four points, O, O', O_1, and O_1', were then marked on these two lines at the height of the center of the ring, and four points, A, A', A_1, and A_1', at the height of the plane of contact of the crown bars and the brackets; each of the lengths, $O\ A$, was divided into four equal parts at the points a, b, c, etc. The points O, being at the height of the mud-ring, were taken as a base of the vertical expansions. The variations of the intervals, $O\ a$, $O\ b$, etc., were measured during heating by means of two gauges having, when cold, the original lengths of $O\ a$, $O\ b$, etc. As for the arcs, $A\ A_1$, $A'\ A'_1$, of the fire-box, fig. 2, they were divided into four equal parts, and the variations of the intermediate arcs were measured by means of a two-point gauge made in the same way.

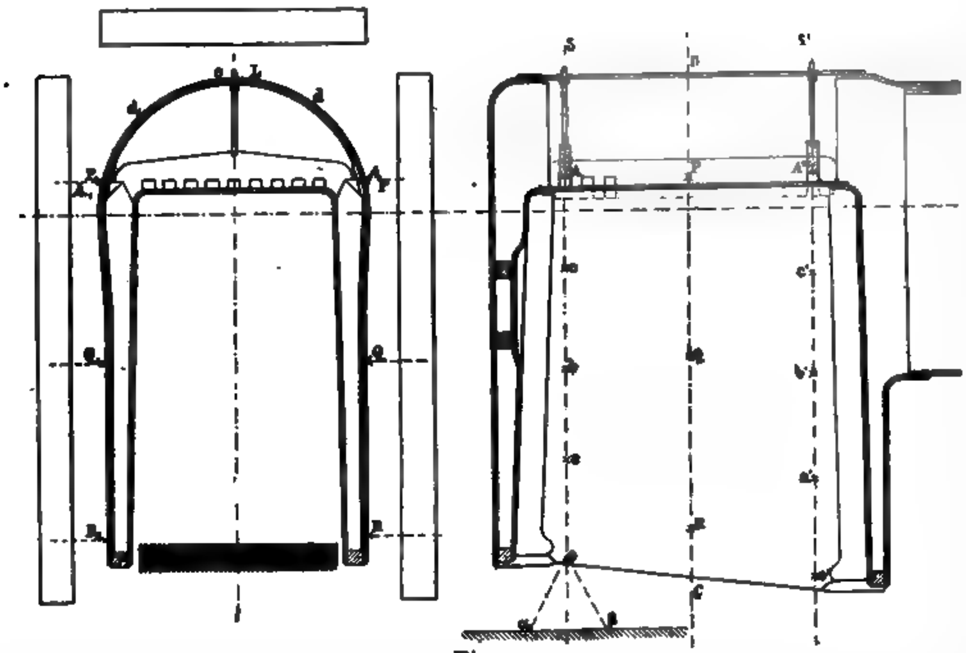


Fig. 2.

The transverse expansions were measured in the vertical plane $C\ D$, fig. 2, drawn at right angles to the axis of the boiler through the center of the interval which separates the two end crown bars. On a line determined by the intersection of this plane with the external surface of the fire-box the following points were marked: P, P_1 at the height of the brackets, and R, R_1 about 4 in. above the ring. Q, Q_1 at the center of the interval which separated these other two points. Two vertical scales were fastened to each side of the fire-box and opposite the points P, Q, etc., and scales of the small plates of zinc were placed, upon which the movement of these points was traced by means of one-point gauges.

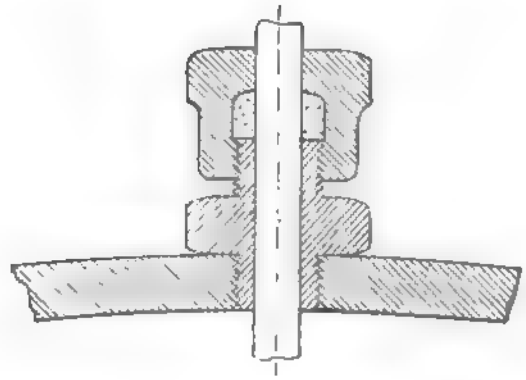


Fig. 3.

Before beginning the heating, the fire-box was carefully examined in all parts to determine whether its walls, and especially the crown sheet, had not been subjected to some deformation which could falsify the results of the experiments: the side sheets were found to be perfectly flat, and the crown sheet was not distorted in any way. They then made sure that there was an absolute contact between the crown bars and the brackets which carried them. Finally it was necessary to be sure, at all times during the experiment, that the position of the ring of the fire-box, which was the base of all the measurements, remained stationary. For this purpose the distances of each of the points O, from two fixed points α and β, were established by one-point gauges having the length $O\ \alpha$. The intersection of the two arcs of the circles described from α and β with $O\ \alpha$ and $O\ \beta$ for radii fixed a point corresponding to the initial position of the point O. It was therefore very easy to determine the displacement which the point O had been subjected to. By means of gauges fixed in this way a trace of the pistons corresponding to the different temperatures when cold could be observed. The fire was lighted and the temperature steadily raised. The variations of the fire-box and of the outer shell were traced simultaneously every five minutes, until the pressure of the steam had risen to 14 lbs. per square inch. Starting from this pressure, the expansions of the different parts of the fire-box were taken at each rise of 1 kg. (14.19 lbs.) in pressure. The pressure of 1 kg. (14.19 lbs.) was reached 45 minutes after lighting the fire; the test was carried on until a pressure of 11 kgs. (156 lbs.), corresponding to the working pressure of the boiler, was reached. This maximum pressure was reached in 1 hour, 45 minutes after lighting the fire. The positions of the points O and O' having been verified during the rise in pressure by

means of the gauges $O\ a$, they found that during the whole of the test the ring of the fire-box had been subjected to no variation which could falsify the measurement. The points O and O'_1 were slightly moved at the pressure of 11 kgs. (156 lbs.) by about .04 in. toward the front, and the points O and O_1 by about .08 in. toward the back, but each of these two points remained in the same horizontal plane.

Vertical Expansions of the Shell.—The following table gives the value of the vertical expansions of the shell taken at each kilogram of pressure:

The results are represented graphically by the curves of fig. 5. These curves are constructed in the following manner: On the axis $O\ x$ three points, $P\ Q\ R$, equidistant from each other, are taken; then upon the ordinates of these points lengths proportional to the values observed for the displacements of the points $P\ Q\ R$, on a pressure of 1, 3, 6, and 11 kgs. per square centimeter (14.22, 42.57, 85.14, and 156 lbs. per square inch), were laid out. The points obtained were then united by a continuous line, and the curves thus traced can be considered as representing approximately the transverse expansions of the line $P\ Q\ R$, fig. 2, at each of the pressures indicated above.

RIGHT SIDE.

FRONT.

Pressures.		$O'\ a'$		$O'\ b'$		$O'\ c'$		$O'\ A'$	
Kil. per sq. cm.	Lbs. per sq. in.	Mm.	In.	Mm.	In.	Mm.	In.	Mm.	In.
1	14.22	0.3	.010	0.7	.028	1.1	.043	1.5	.060
2	28.44	0.5	.020	1.0	.040	1.5	.060	2.0	.080
3	42.67	0.6	.024	1.2	.050	1.8	.070	2.4	.090
4	56.89	0.7	.028	1.4	.055	2.1	.080	2.9	.110
5	71.08	0.8	.030	1.6	.060	2.4	.090	3.3	.130
6	85.33	0.9	.035	1.8	.070	2.7	.100	3.7	.146
7	99.52	1.9	.035	1.9	.075	2.9	.110	3.9	.153
8	113.80	1.0	.040	2.0	.080	3.0	.120	4.0	.160
9	128.00	1.0	.040	2.0	.080	3.0	.120	4.0	.160
10	142.00	1.0	.040	2.0	.080	3.0	.120	4.0	.160
11	156.00	1.0	.040	2.0	.080	3.0	.120	4.0	.160

BACK.

Pressures.		$O\ a$		$O\ b$		$O\ c$		$O\ A$	
Kil. per sq. cm.	Lbs. per sq. in.	Mm.	In.	Mm.	In.	Mm.	In.	Mm.	In.
1	14.22	0.4	.016	0.8	.030	1.2	.050	1.7	.067
2	28.44	0.5	.020	1.0	.040	1.5	.060	2.0	.080
3	42.67	0.5	.020	1.2	.050	1.7	.067	2.3	.090
4	56.89	0.6	.024	1.3	.050	1.9	.075	2.6	.100
5	71.08	0.7	.028	1.4	.055	2.1	.080	2.9	.110
6	85.33	0.8	.030	1.6	.060	2.3	.090	3.2	.130
7	99.52	0.8	.030	1.7	.067	2.4	.090	3.3	.130
8	113.80	0.9	.035	1.7	.067	2.5	.098	3.4	.134
9	128.00	0.9	.035	1.7	.067	2.5	.098	3.5	.140
10	142.00	0.9	.035	1.7	.067	2.5	.098	2.5	.140
11	156.00	0.9	.035	1.7	.067	2.5	.098	3.5	.140

LEFT SIDE.

FRONT.

Pressures.		$O'_1\ a'_1$		$O'_1\ b'_1$		$O'_1\ c'_1$		$O'_1\ A'_1$	
Kil. per sq. cm.	Lbs. per sq. in.	Mm.	In.	Mm.	In.	Mm.	In.	Mm.	In.
1	14.22	0.5	.020	1.0	.040	1.5	.060	2.0	.08
2	28.44	0.6	.024	1.2	.050	1.8	.070	2.4	.09
3	42.67	0.6	.024	1.3	.050	1.9	.075	2.6	.10
4	56.89	0.7	.028	1.4	.055	2.1	.080	2.9	.11
5	71.08	0.8	.030	1.6	.060	2.5	.098	3.2	.13
6	85.33	0.9	.035	1.7	.067	2.5	.098	3.5	.14
7	99.52	0.9	.035	1.8	.070	2.8	.110	3.8	.15
8	113.80	1.0	.040	1.9	.075	3.0	.120	4.0	.16
9	128.00	1.0	.040	2.0	.080	3.0	.120	4.0	.16
10	142.00	1.0	.040	2.0	.080	3.0	.120	4.0	.16
11	156.00	1.0	.040	2.0	.080	3.0	.120	4.0	.16

BACK.

Pressures.		$O_1\ a_1$		$O_1\ b_1$		$O_1\ c_1$		$O_1\ A_1$	
Kil. per sq. cm.	Lbs. per sq. in.	Mm.	In.	Mm.	In.	Mm.	In.	Mm.	In.
1	14.22	0.4	.016	0.9	.035	1.6	.060	1.8	.070
2	28.44	0.5	.020	1.0	.040	1.6	.060	2.1	.080
3	42.67	0.6	.024	1.2	.050	1.8	.070	2.4	.090
4	56.89	0.6	.024	1.4	.055	2.0	.080	2.7	.100
5	71.08	0.7	.028	1.5	.060	2.1	.080	2.9	.110
6	85.33	0.8	.030	1.6	.060	2.3	.090	3.2	.130
7	99.52	0.8	.030	1.7	.067	2.4	.090	3.4	.134
8	113.80	0.8	.030	1.7	.067	2.5	.098	3.5	.140
9	128 00	0.8	.030	1.7	.067	2.5	.098	3.5	.140
10	142 00	0.8	.030	1.7	.067	2.5	.098	3.5	.140
11	156 00	0.8	.030	1.7	.067	2.5	.098	3.5	.140

The result of column 4 of each of the above tables is represented by the curves of fig. 4. These curves are constructed by taking the pressures for the abscissas and the expansions of the length $O\ A$, $O_1\ A_1$, $O'\ A'$, $O'_1\ A'_1$ for the ordinates. The points O having been taken at the height of the center of the ring, and the points A at the height of the plane of contact of the crown bars and the brackets, the four curves represent the vertical displacement of the four extreme brackets, since, as has been stated, the points O were not displaced vertically. Thus the full-line curve gives the vertical displacement of the extreme front bracket on the left, and the dotted curve the vertical displacement of the extreme back bracket on the left, etc. It has, furthermore, been stated that the arcs $A\ A_1$, $A'\ A'_1$ did not expand regularly; the variations observed for the four equal arcs in which each one of them had been divided was exactly the same. The maximum variation measured for each of these small ordinates was .05 in. for a pressure of 156 lbs. to the square inch.

Transverse Expansions of the Outer Shell.—The expansions measured in the vertical plane $c\ d$, fig. 2, and at three points, $P\ Q\ R$, was determined, as has already been described. They were only taken at four intervals corresponding to pressures of 1, 3, 6, and 11 kgs. per square centimeter (14.22, 42.57, 85.14, and 156 lbs. per square inch). The following table gives the values of the expansions which were observed:

Vertical Expansions of the Fire-Box and the Outer Shell.—The fire-box expanded rapidly at the beginning of the test; five minutes after lighting the fire these expansions had already amounted to as much as .01 in. The variations of the shell were very much slower, and they did not begin to be appreciable, showing .006 in., until 20 minutes after lighting the fire. Nevertheless, during the whole period of the beginning of the heating, the variations were taken simultaneously for the fire-box itself and for the outer shell, at intervals of five minutes until the steam pressure reached 1 kg. per square centimeter (14.22 lbs. per square inch). Starting from this point, the measurements were taken only at intervals of time corresponding to a rise of 14.22 lbs. per square inch in pressure.

Table No. III. gives the values found for these variations.

The results are shown graphically and by curves of figs. 6 and 7. The curves of fig. 6 show the comparative expansions of the fire box on the outer shell during the period of the beginning of the heating—that is, until the pressure reached the 1 kg. per square centimeter (14.22 lbs. per square inch). They are laid out by taking the time for the abscissas and the expansions at five-minute intervals for the ordinates. The curves of fig. 7 have been obtained by taking the pressures for the abscissas and the expansions taken for each kilogram of rise in pressure for the ordinates.

RIGHT SIDE.

Pressures.		P		Q		R	
Kil. per sq. cm.	Lbs. per sq. in.	Mm.	In.	Mm.	In.	Mm.	In.
1	14.22	1.25	.050	1.5	.06	0.5	.02
3	42.67	1.50	.060	1.8	.07	0.7	.03
6	85.33	1.90	.080	2.4	.09	0.8	.03
11	156.00	2.50	.100	3.0	. 2	1.0	.04

LEFT SIDE.

Pressures.		P_1		Q_1		R_1	
Kil. per sq. cm.	Lbs. per sq. in.	Mm.	In.	Mm.	In.	Mm.	In.
1	14 22	0.75	.030	1.1	.04	0.35	.01
3	42.67	1.10	.040	1.3	.05	0.45	.02
6	85.33	1.40	.055	1.6	.06	0.60	.02
11	156.00	1.20	.050	2.1	.08	5.70	.02

TABLE III.

Pressures.									Lbs. 14.22	28.44	42.67	56.89	71.08	85.33	99.5	113.8	128	142	156
Time.																			
Front.... Firebox	.001	.002	.036	.070	.087	.110	.12	.130	.15	.16	.17	.18	.19	.19	.190	.19	.19	19	.19
Front.... Shell	....	..	...	.006	.012	.020	.03	.040	.05	.09	.11	.12	.14	.16	.165	.18	.19	.19	.19
Back .... Firebox	.001	.002	.030	.040	.060	.070	.83	.100	.11	.18	.14	.16	.18	.19	.190	.19	.19	.19	.19
Back .... Shell	...	....	...	.006	.012	.018	.80	.086	.05	.10	.106	.12	.14	.15	.170	.18	.19	.19	.19

Finally, in order to compare the results obtained as easily as possible, the three curves showing respectively the expansion of the fire-box and the different portions of the shell have been brought together in the same figure. Thus the curve λ shows the expansions of the fire-box measured from the top of the rod, which is screwed into the crown bar; the curve μ the expansions of the outer shell measured at its highest point; the curve ν the expansion of the shell measured at the height of the brackets (average of the expansions of the right and left side).

The differences in the ordinate of the curves λ and μ corresponding to the same abscissa represents at each moment of the test the distance which separates the ends of the crown bars from their brackets. The ordinates of the curve λ represent the vertical rise of the crown bars increased by the expansion of the crown bar itself, and the rod which rises from it.

The ordinate of the curve μ represents the vertical rise of the brackets increased by the vertical expansion of the arc $A\ A_1$.

Now, the bend of this arc is practically equal to the sum of

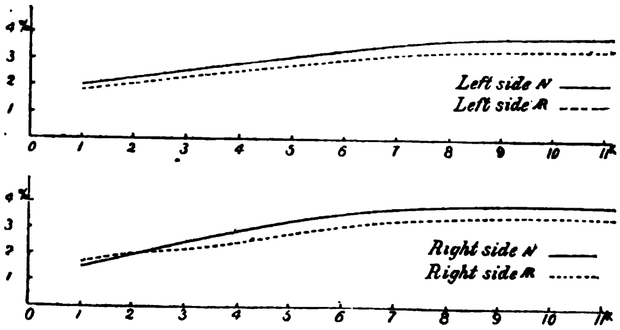


Fig. 4.

the lengths of the crown bar and the rod. As this rod is of the same temperature as the shell, and as, on the other hand, the test showed that the arc $A\ A_1$ expands regularly, the vertical expansion of this arc is equal to the sum of the expansions of the crown bar itself and the rod.

The ordinates of the curves λ and μ therefore represent respectively the vertical displacement of the ends of the crown bars and the brackets both increased by the same quantity.

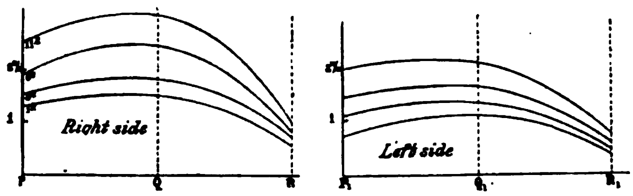
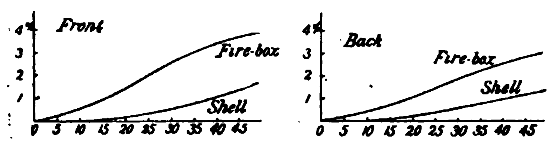


Fig. 5.

Consequently the difference of these ordinates represents the interval which separates the ends of the crown bars from their brackets. This having been demonstrated, it is easy to deduce from an examination of the curves, figs. 6 and 7, the course of the phenomena which occur during the expansion and the generation of a pressure in the boiler. As soon as the fire is started the crown-sheet of the fire-box rises; the crown bars leave their brackets; the interval which separates them increases, and reaches a maximum of from .08 to .1 in. at a pressure a little below 1 kg. per square centimeter (14.22 lbs. per square inch). The pressure of steam upon the fire-box gradually checks this ascensional movement of the bars; starting from the time when the pressure reaches 6 kg. per square centimeter (85.14 lbs. per square inch), the crown bars remain practically stationary; the pressure of the steam is then sufficient to counterbalance the strain of expansion.

At no time does the pressure exerted by the steam produce

Fig. 6.



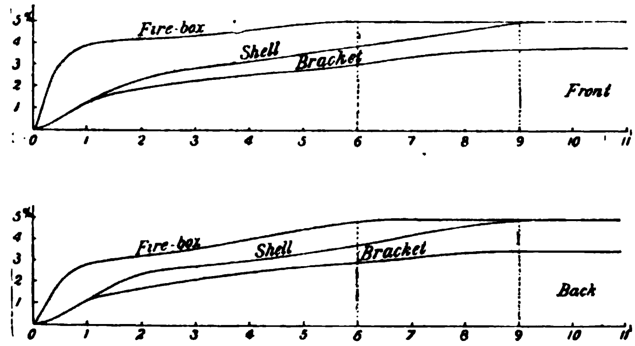


Fig. 7.

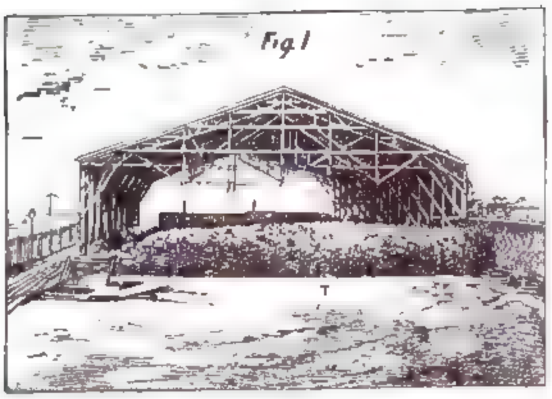
any deflection of the crown sheet—that is to say, there is never any negative variation. In the mean time, the brackets following the variations of the temperatures of the mass of water on that of the fire-box rise slowly and gradually. The interval which separates the ends of the crown bars diminishes from the time the pressure reaches 1 kg. per square centimeter (14.22 lbs. per square inch), and at a pressure of 9 kgs. (128 lbs.) the brackets and ends of the crown bars come together, and from this time on the contact established remains fixed. The test was only carried on until a pressure of 11 kgs. (156 lbs.) was reached. The fire was then drawn and the cooling of the boiler watched. The variations of the fire-box and of the outer shell were observed at decreasing pressures. The variations measured were exactly the same as before for the fire-box and shell.

Conclusions.—The conclusions which can be deduced from this experiment for boilers of a type similar to the one examined are as follows:

1. On starting the fire the crown-sheet of the fire-box rises freely. The crown bars do not hinder this movement. They rise with the crown-sheet, and are separated from their supports.
2. The interval which separates the crown bars from their supports reaches a maximum of from .08 to .1 in. when the pressure is about 14.22 lbs. per square inch.
3. Some time before the maximum pressure is reached the crown bars are back again in contact with their supporting brackets.
4. Finally, under the normal conditions of running, the contact remains fixed permanently between the crown bars and their supports.

TRANSPORTING BUILDINGS.

The transportation of a hotel in Coney Island, from one site to another, was a remarkable piece of work of its kind. A similar work, but on a less pretentious scale, has been recently executed at Rouen, and as the details of the operation are both interesting and instructive, we extract our information and cuts from our contemporary, *Le Genie Civil*. The building removed consisted of a large shed, constructed of timber



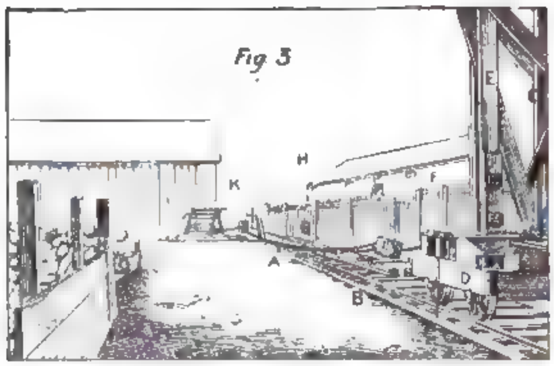
MOVING A LARGE SHED AT ROUEN.

and iron, on the Polonceau system, 164 ft. long by 97 ft. in width, in a single span. There were 12 trusses in all, and consequently 11 bays, each of which had a length of 14 ft. 6 in. The roof principals are supported on double posts, as shown on figs. 1 and 2, measuring transversely over all about 3½ ft., and respectively 13 in. and 9 in. in breadth. They rest upon brick blocks or small pillars, having sheet iron beds, and are 24 ft. in height above the sill. The rafters consist of a trussed girder 2 ft. 7 in. in depth, with upper and lower solid timber chords, united by vertical and diagonal struts and ties, also of wood. Double raking struts are run from the half length and the feet of the side posts to brace the whole framework solidly together. Each rafter carries five purlins 9 in. by 3½ in., which, together with the ridge piece and the pole plate, support the common rafters. In addition to the truss composing the main rafter, the entire roof principal is strengthened by iron in the following manner: A tie-rod, slightly raised at the center, connects the two opposite posts. Two cast-iron vertical struts attached to the central part of the lower chord of the rafter carry a couple of iron tie-rods, one of which is connected with the ridge, and the other with the feet of the rafters. Between the posts, timber bracing in the form of St. Andrew's cross, and horizontal ties are introduced, as shown in fig. 2.

TRUCKS UNDER EACH PRINCIPAL.

Tiles are used for the covering, and the roof has a slope of 20°. Adding the weight of the rolling load, 32 tons, to 148 tons, the weight of the shed, we have a total load of 180 tons to be shifted.

It is obvious that the crucial part of the undertaking was in the displacement of the 24 supporting posts at one and the same time. It was also absolutely indispensable that this lifting operation should be accomplished in a manner which would not in the least degree alter or disarrange the relative positions of the posts. A very slight distortion or deformation at the base of the rectangle formed by the shed would have given rise to very serious consequences. Fortunately for the economical item in the transport, the slope of the ground over which the shed had to be moved was inappreciable, and the posts when in their new position would only require to be raised some 10 in. For these reasons the tractive, lifting, and other mechanical appliances required were not of a very elaborate or expensive character, being composed of a couple of winches, cables, and some strong blocks, which had been previously employed in hoisting some of the flat-bottomed native craft into a workshop in Rouen. Rails, sleepers, wagon axles, screw-jacks, and other necessary plant were procured with facility, and the construction of the special trucks completed the preparations. Before commencing the work, the first step consisted in laying down a rail track underneath each line of posts, as shown in fig. 2, and then building round each double pillar a truck mounted upon two axles, with wheels 2 ft. in diameter. These axles are 4 ft. 3 in. apart, and are united by longitudinal side and end pieces of oak bolted together and forming the frame of the truck, figs. 2 and 3. Upon the side pieces are placed two cross sleepers of pine, which carry the vertical flitches bolted lengthways to the posts. The cross sleepers are maintained in their place on the frame of the truck by four chocks bolted on. In order to lift a post on to its special truck, it was necessary to raise the sleepers by screw-jacks about 3½ in., and since they are bolted to the post, the latter cleared its brick pillar, and was kept in place by suitable wedges driven in between the bottom of the sleepers and the side frame of the truck. As a precaution against the occurrence of any deformation of a magnitude likely to be



CONNECTION OF TRUCKS AND HAULING TACKLE.

dangerous, a pair of posts in the same range were lifted at a time, the whole 3½ in. being divided between a couple of lifts. As soon as all the trucks had received their loads they were coupled together by wrought-iron rods 1¼ in. in diameter to transmit the traction in the line of the posts, and also for the purpose of preserving the exact distance between them. It was necessary to arrange the lift in such a manner that when the cross sleepers had to be lowered they should not touch the side frame of the truck before the posts had taken their bearings upon the new piers, as it was impossible at that stage of the operations to dismount the axles.

At the far end of the distance to be traversed, about 200 ft., and in alignment with the axis of each of the two lines of posts, was fixed the hauling arrangement, which was thus installed. A couple of oak piles, 20 ft. long and 14 in. in diameter, were driven into the ground by a small pile-driver, one at a distance of 30 ft. from the middle of the last principal when in its new position, and about 1 ft. out of the line of the longitudinal axis of the posts. The other was driven at a distance of only 22 ft. from the same point, as a small building prevented it being placed further off. These piles constitute the *points d'appui* for the whole of the haulage; and to each of them was attached a block with three pulleys, 1 ft. in diameter, while another block was fixed to a stirrup which was fastened to the two cross sleepers of the leading truck. At each side of the two large mooring piles already described another pile was driven, 10 ft. in length and 9 in. in diameter, which served as a fixed point for the haulage cable, which, starting from here, passes successively round the two blocks, forming a pulley with six sheaves. It then winds on a winch placed inside the building at a distance of 12 ft. from the line of axis of the posts, and 4 ft. from the line of the middle of the last principal when in its new position.

The cable has a diameter of 2 in., and the winch a drum 1 ft. 8 in. in diameter. In front of this winch, on the same frame, a second drum is fixed capable of turning freely on its axis, the object of which is to prevent the lateral displacement of the cable during the haulage. A reference to fig. 3 will explain the position of the different pieces of mechanism employed in effecting the transportation of the shed. *A B C* is the graduated plank laid down along the whole length of the route to insure uniformity of progression in all the separate trucks. At *C* the pointer is shown which is attached to the leading truck on each side, and, by the conditions laid down, the distance or the number of graduations passed over at any time is a known quantity. The trucks and the roof posts are *D* and *E*, while *F* is the pulley block through which the hauling ropes pass to the winch. The fixed point already mentioned is the pile driven at *H*. In the event of the progression not being uniform for both lines of haulage, the men working the winches were signalled to slacken or accelerate the motion so as to preserve the necessary parallelism between the two lines of traction. This system answered exceedingly well, as the greatest discrepancy did not exceed a ½ in., while the smoothness of the movement did not permit of a single flaw making its appearance in the structure, or of a glass breaking.

A useful comparison may be drawn here between the conditions attending the haulage of the trucks carrying the shed and a goods train composed of the same number of wagons. Each wagon of the train, although connected with its two neighbors in front and rear does not constitute a component part of a rigid frame, which would be destroyed if any distortion or deformation took place. On the contrary, the couplings allow a certain amount of "play." In starting, therefore, a train of a dozen wagons, supposed of uniform weight, the locomotive has to overcome only one-twelfth of the total inertia of the whole load, as the wagons get off successively and not simultaneously. But with the 12 trucks in each train carrying the posts of the shed it was essential to make the attachments of a solid character by means of bracing, so as to keep their relative distances unaltered, and also before starting the total inertia of the mass to be transported had to be overcome. The conclusion to be drawn from the undertaking we have described is, that in the horizontal displacement of large rigid masses, carried on trucks on rails, we may take, without laying down any hard-and-fast line, the coefficient of traction at 0.07 of the weight of the load to be transported.—*The Engineer.*

THE USE OF GAS MOTORS IN GERMANY.

Mr. Frank H. Mason, Consul General of the United States to Germany, has made a report on the Use of Gas Motors in Germany, from which we make the following extract:

"Prominent among the economies which have been introduced during recent years in Germany is the use of gas motors in place of steam-engines in all the smaller forms of manufacture where the motive force required does not exceed 75 to 100 H.P. At the Frankfort Electrical Exposition of 1891 most of the dynamos were driven by gas and caloric engines, and the display of these motors at that time was almost as varied and interesting to the general public as that of the electrical apparatus to which they were technically subsidiary.

There were in operation at that time throughout Germany about 15,000 gas motors, with an aggregate motive force of 60,000 H.P. Since then the gradual cheapening of gas and the rapid extension of electrical lighting and electrolysis have combined to increase very rapidly the use of gas motors, the effectiveness and economy of which were so brilliantly demonstrated at the Frankfort Exposition. No statistics are available to show the precise number that are at present in use; but, as the two principal makers of gas-engines in Germany have alone made and delivered during the past two years 1,950 motors, it may fairly be inferred that the number in actual service in this country is not far short of 24,000 or 25,000.

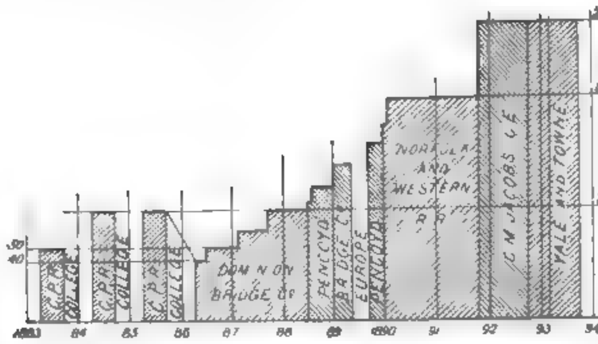
Meanwhile the progress that has been made in improving the machines and increasing their economy has been quite remarkable. The first gas motors, which were exhibited and used experimentally about 1868, were fatally extravagant. The Lenoir machine, which was the best model known to Germany as late as 1861, used—according to a recent statement in *Kuhlow's Trade Review*—1,235 cub. ft. of gas per H.P. per hour, whereas the motors now in use consume only 28 ft. per H.P. per hour in small machines, and in large sizes as low as 23.75 ft.; so that 21.2 cub. ft. of gas per hour will run an incandescent lamp of 16 candle power, and this proportion is said to have been reduced in large plants which employ motors of 500 H.P. and more to 17.6 cub. ft. of gas per H.P. per hour.

How economical such a motive power must be for all the smaller forms of manufacture, and especially for electrical lighting by isolated plants, will be apparent from the following tabular statement of the price per 1,000 cub. ft. of gas which prevails at present in the principal cities of Germany:

Altona, Bremen, and Mayence	$1 36
Brefeld (with discount to large consumers)	1 32
Brunswick, Bonn, and Strasburg (without discount)	1 21
Magdeburg, Leipsic, and Breslau (with discount)	1 21
Barmen (with discount)	1 19
Dantzig and Dresden	1 14
Berlin and Königsberg (without discount)	1 09
Cassel, Dortmund, Elberfeld, and Hanover (with discount)	1 09
Frankfort (with discount)	1 07
Stettin, Essen, and Cologne	1 02
Bochum	95

AN ENGINEER'S CAREER REPRESENTED GRAPHICALLY.

A short time ago a young engineer called at the office of The American Engineer seeking employment. Among the documents which he submitted as evidences of his past experience was a blue print, from which the diagram herewith has been engraved. In this the horizontal distances represent time, and the base-line is divided into spaces which represent years, as indicated by the figures below it. The vertical distances represent his salary, as indicated by the horizontal lines, and the figures at the ends of them indicate the amounts received per month. The diagram shows that he began his career on the Canadian Pacific Railway at $50 per month. In alternating periods he was in college, and with the Canadian Pacific Road later at $75 per month. In 1886 he went to the Dominion Bridge Company, when the slip-like diagram shows successive increases in salary. The same is true of his connection with the Pencoyd Company. Afterward he went with the Norfolk & Western Road, and received $150 when he left. Still later he was employed by C. M. Jacobs, and afterward by Yale & Towne at $200 per month.



GRAPHICAL REPRESENTATION OF AN ENGINEER'S CAREER.

Such a diagram is an excellent one for people out of employment to have. It shows at a glance what they have done and what they have been paid, and is a graphical history of their past careers and experience.

As intimated at the beginning of this notice, the author of this diagram is out of employment and wants a "job." It is safe to say that any one able to do as creditable and ingenious a piece of work as the diagram shown by our engraving has the ability of making himself very useful wherever he may be employed. His name and address may be obtained by addressing the Editor of The American Engineer.

THE LUHRIG COAL WASHING PLANT.

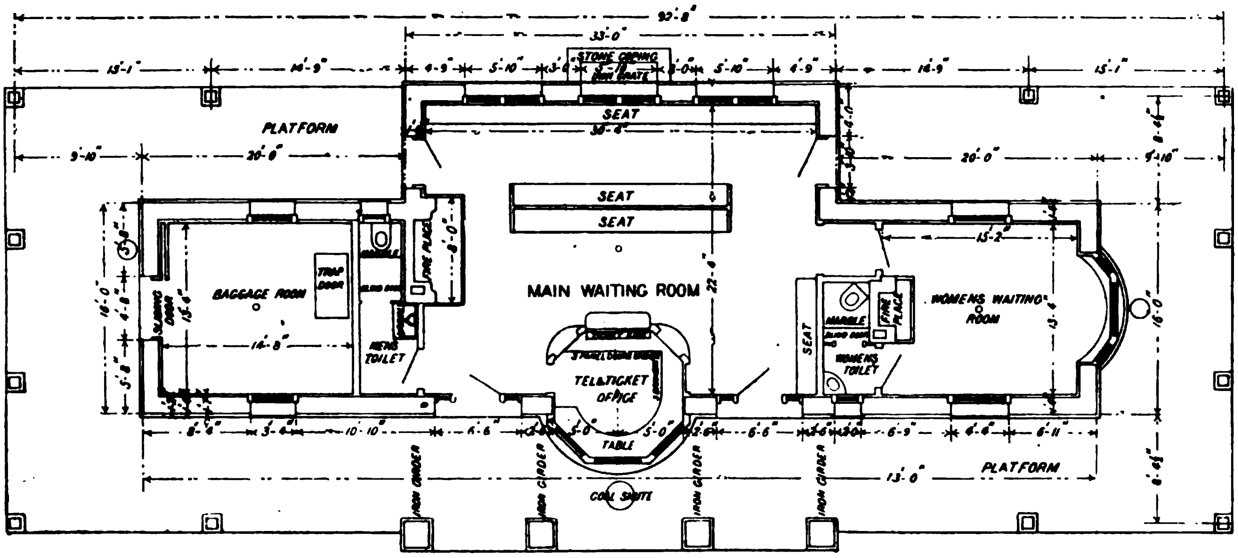
At the September meeting of the British Iron and Steel Institute, James l'Anson, of Darlington, read a paper describing the Luhrig coal washing and dry separation plant, which was then in process of construction at a pit of the North Bitchburn Coal Company, Evenwood. This plant is to handle 1,000 tons of coal per day as drawn from the pit. It has two drawing shafts from which the coal as it comes to bank is run into tipplers of improved construction, whence it is delivered by means of short traveling bands on to the shaking screens, of

Station at Westfield, N. J.

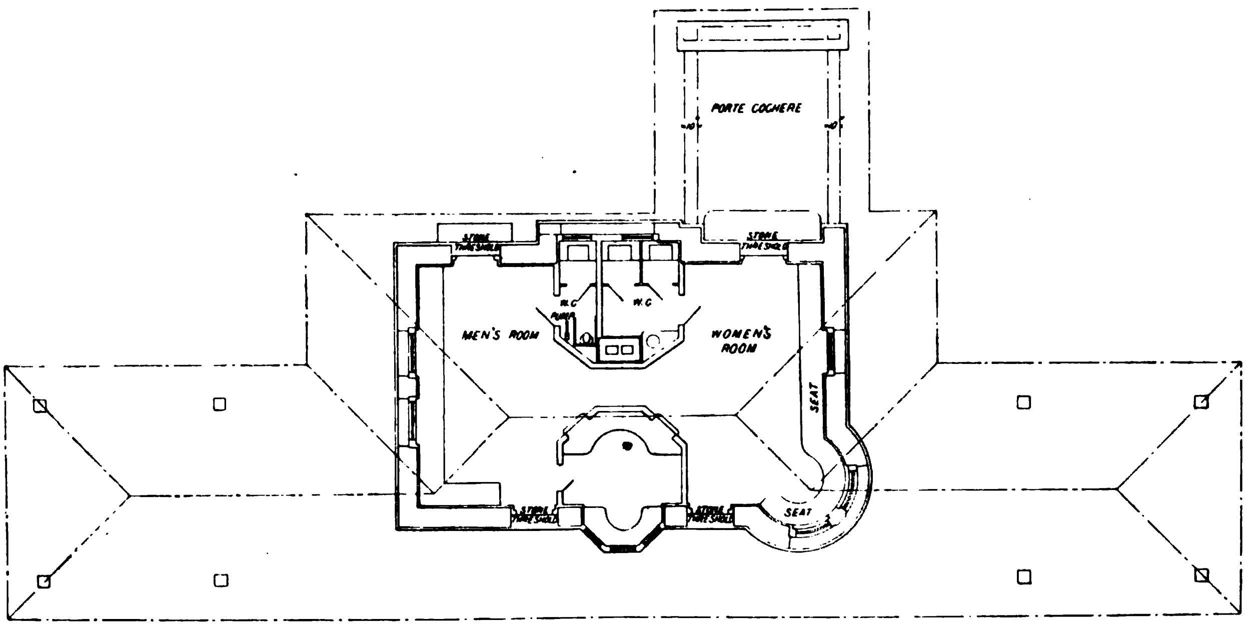
Station at Interlaken, N. J.

Station at Little Silver, N. J.

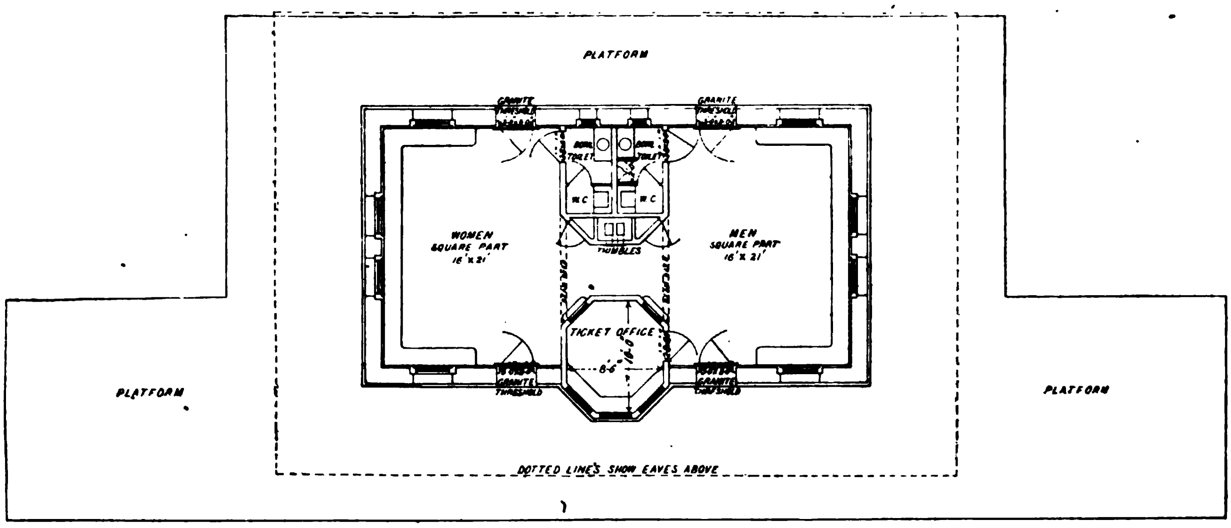
SUBURBAN STATIONS ON THE LINE OF THE CENTRAL R. R. OF NEW JERSEY. PHOTOGRAPHED BY PACH BROTHERS, NEW YORK.



GROUND FLOOR PLAN OF STATION AT WESTFIELD, N. J.



GROUND FLOOR PLAN OF STATION AT INTERLAKEN, N. J



GROUND FLOOR PLAN OF STATION AT LITTLE SILVER, N. J.

SUBURBAN STATIONS ON THE CENTRAL RAILROAD OF NEW JERSEY.

which there are three, inclined at a somewhat low angle. These screens are formed of plates pierced with round holes, which insures a more uniform sizing than where bar screens are employed. Any desired size of mesh can be used by putting a suitable plate into the screen. Usually holes of about 2¼ in. diameter are employed.

All the coal which passes over these screens falls on traveling belts, upon which it is hand picked. Two of these belts are formed of bars carried by links, so that any small coal resulting from the cleaning process falls through the spaces between the bars on to flat sheets, whence it is carried by scrapers, placed transversely to the line of the belt back on to a transverse traveling belt, delivering it into a large hopper, which also receives the whole of the coal passing through the screens. The third belt is formed of close plates instead of bars, in order that it may be used for dealing with unscreened coal if required, in which case a blind plate is put into the corresponding screen in place of the perforated one.

At the end of each belt is a loading arm, round which the belt passes. This can be lowered into the empty truck which is to be filled by means of hydraulic power, and gradually raised as the truck fills, thus saving any appreciable drop and consequent breakage of the coal.

The coal passing through the screens falls on to a traveling belt formed of plates in the trough form, by which it is delivered into a large hopper situated just outside the washery building and below rail level. A second belt, parallel to the first, delivers into trucks, so that the coal passing through the screens can be automatically loaded at once, should it be desired to send it away unwashed. Provision is also made for separating nuts of any required size, by putting a second plate in the screen, which can be delivered on to the second traveling belt, to be loaded unwashed if desired.

All the coal which goes into the large hopper is taken by an elevator to the top of the washery building and delivered into a sizing drum or revolving screen, where it is sorted into nuts 2¼ in. to 1½ in., 1½ in. to 1 in., and 1 in. to ⅜ in. diameter (these being the sizes of the round holes in the shells of the sizing drum), and small from ⅜ in. downward. Each size of nut then falls down its appropriate shoot into its own washing-box. These washing-boxes are formed of wood lined with plate, and are divided longitudinally into two sections by a partition not quite reaching to the bottom. In the front compartment of the box is a sieve on to which the nuts are delivered, and here they are met by the washing water, forced to the top of the building by a centrifugal pump.

Near the top and to the front of the box is a longitudinal opening, out of which the water flows, carrying the washed coal, while lower down and just above the level of the sieve is another opening for the escape of the refuse. At the bottom of the box, which is hopper shaped, is a valve which can be opened when required to let out any fine refuse which has passed through the sieve. The back compartment of the box is fitted with a wooden piston, actuated by an eccentric of appropriate throw, upon a line of shafting, the stroke of the piston being proportioned to the size of the material under treatment.

The washed coal passes from the front and top of the box into a draining shoot, to which a vibrating action is given to separate the water more effectually, and from the draining shoot the nuts are delivered into loading hoppers, under which trucks are run and loaded through a sliding door in the bottom of the hopper.

The refuse, to some of which a certain amount of coal is adherent, is delivered from its proper exit into a conveyer, whence it is taken to a pair of crushing rollers in order to separate the adherent or intergrown coal.

From this point it is taken by an elevator to a sizing drum, graded into two sizes, and delivered into two re-washing boxes, in which the coal is recovered and can be disposed of as required.

The small coal delivered from the large sizing drum in size of three-eighths and downward, meets the used washing water from the nut boxes, by which it is conveyed into a grading-box situated behind the small coal washing-boxes.

Each section of the grading-box delivers its own size of coal into a washing-box similar in construction to the nut washing-boxes, but having a layer of feldspar crystals resting upon the sieve. The necessary impulse is given to water by pistons similar to those already described, but of shorter stroke, proportioned to the fineness of the coal to be treated. This bed of feldspar is an important factor in the washing of fine coal, opening and closing with the impulse of the water, and permitting the heavier dirt to pass through while the coal is suspended above.

The washed fine coal passes out of the front of the boxes, as already described in the case of the nuts. The dirt passes through the feldspar and is delivered from the bottom of the boxes, after which it mixes with the product from the crushing rollers, and is re-washed with it in the special boxes already described.

The washed small coal passes from the washers into a draining drum of $\frac{1}{32}$ in. mesh, all the coal above this size being subsequently taken by an elevator into storage hoppers for delivery to the coke ovens or elsewhere. The effluent water, with all the finest coal below one thirty-second, passes into the sludge recovery.

The sludge recovery consists of a long chamber under the building, with a cemented floor, on which the fine sludge is allowed to settle. In this chamber is a slowly moving belt with cross scrapers, which scrape the sludge off the bottom, and deliver it into a large hopper at the end of the chamber, whence it is taken by an elevator, and can be either mixed with the small coal in the same storage hopper or kept separate, as required.

The degree of efficiency secured by a plant such as is described above may be gauged by the guarantees given by the Luhrig Company in the case of the one erected at Motherwell, and which has been fully borne out in practice. These guarantees are as follows: Capacity of plant, 1,500 tons per day of 10 hours, on the basis of the coal containing 23 per cent. of ash. Ash contained in washed coal of five-sixteenths to one-thirty-second not to exceed 6 per cent. The rubbish or dirt which has been washed out is guaranteed not to contain more than 2 per cent. of fine coal. The cost of labor is guaranteed not to exceed eight-tenths of a penny per ton of coal handled, including labor in hand picking, sorting, washing, and loading into trucks. In practice, it is found that the ash does not exceed 2½ per cent., the coal in the dirt 1 per cent., and the labor ½*d.* per ton.—*American Gaslight Journal.*

RAILROADING UNDER THE REIGN OF GEORGE IV.

On another page we give a fac-simile copy of a placard, which gives "An Abstract of Penalties Imposed by the Act of Parliament of George IV., for making the Stockton and Darlington Railway," which is dated July 10, 1827. The original, from which this was made, was among the papers of the late Horatio Allen, and was probably obtained by him at the time he was in England, and contracted for the first locomotives ever brought to this country. It was reduced to just half the linear scale of the original in order to admit of being printed on a page of The American Engineer. It requires either good eyesight or strong glasses to be read, but will repay the close attention required to decipher it. Some of the rules are very quaint, and have an ancient flavor that is interesting. For example, Rule 6, "Every person neglecting to shut Gates made across the Railway through which he shall pass, shall forfeit a Sum not exceeding £2." Probably Rule 7 might be adopted in many places in this country to the advantage of shippers. It reads: "Every Wharfinger giving a Preference to any Person in the loading or unloading of any Waggon or Waggons shall forfeit a Sum not exceeding £2."

The fifth penalty imposed by the railway company speaks of the gauge of the wheels being "4 *ft.* 5¼ *in. from* the outside of the flange of each wheel." From this it may be inferred that the original gauge of the Stockton & Darlington Railroad was less than 4 ft. 8½ in. Tradition tells us that the rails were originally 5 ft. over their outsides and were 2 in. wide, which would leave the gauge 4 ft. 8 in., and that in order to ease the vehicles on curves the rails were spread an additional ½ in. Even if this were the case, the wheels must have had 1¼ in. end play on each side, or 2½ in. altogether, which now seems excessive.

It would be interesting to know what our trades-unions would say about a rule like 14, which stipulates, "Every Engine-man, Carriage-man, or Waggon-driver, loading Coals, Goods or Materials, on the Company's Waggons, who shall suffer the Axles of such Waggons at their '*bearances*' or journals to be without Oil or Grease, shall forfeit a Sum not exceeding £1."

Regulation 25 is also curious. It stipulates that "Every Person who shall refuse to take the Passing or Siding Place, in the approach of a Locomotive Engine, shall forfeit a Sum not exceeding 10*s.*" The rules which follow and which govern the right of the road also sound curiously in these days of train dispatching and block signals. Rule 28, for example, has an antediluvian flavor. It reads, "Locomotive Engines shall be exempt from taking the Sidings, except in meeting another Locomotive Engine; in that case the Empty Train shall take the Siding."

Stockton & Darlington RAILWAY.

AN ABSTRACT OF PENALTIES,

Imposed by the Act of Parliament of Geo. IV. for Making the said Railway.

	£.	s.	d.
1. ANY Person neglecting or refusing, to give the Collector of the Rates or Tolls, an Account in Writing of the Quantity of Goods or other Things, in any Waggon or other Carriage, from whence brought, and where intended to be unloaded or left, or refusing to produce a Bill of Lading, or giving a false Account, or shall deliver any part of his Lading at any other Place than what is mentioned in such Account, shall forfeit for every Ton so delivered	0	10	0
2. ANY Person Riding, Leading, or Driving, any Horse, Mule, Ass, Cow, or any other Cattle, upon the said Railway, or any Part thereof, shall forfeit a Sum not exceeding	2	0	0
3. ANY Person passing upon the said Railway, with any Waggon or other Carriage not properly constructed, except in crossing the same, by the Occupier of adjoining Grounds, and in passing any Public or Private Roads, shall forfeit a Sum not exceeding	5	0	0
4. EVERY Owner of Waggons neglecting to enter his Name and Place of Abode, and the Number of his Waggons or other Carriages, with the Clerk of the Company, and neglecting to Paint such Name and Number, in white Letters and Figures, on a black ground, three inches high at least; and for refusing to permit such Waggons or Carriages to be gauged or measured at the Expense of the Company, shall forfeit a Sum not exceeding	5	0	0
5. FOR Damage, Spoil, or Mischief, done to the said Railway, and the Works thereof, or to adjoining Lands, by any Waggon or other Carriage, or the Waggoner or other Person belonging thereto, if such Damage do not exceed £10, the Owner thereof shall pay the Amount of such Damage, Spoil, or Mischief, and shall also forfeit a Sum not exceeding	2	0	0
6. EVERY Person neglecting to shut Gates made across the Railway through which he shall pass, shall forfeit a Sum not exceeding	2	0	0
7. EVERY Wharfinger giving a Preference to any Person in the loading or unloading of any Waggon or Waggons, shall forfeit a Sum not exceeding	2	0	0
8. ANY Person suffering any Carriage to remain on the Railway, and obstructing the Passage thereof, and shall refuse to remove such Carriage when required so to do, shall forfeit a Sum not exceeding	0	5	0
9. ANY Person breaking, throwing down, or destroying, stealing, or taking away, any Part of the said Railway, or any of the Works thereof, is subject to the like Pains and Penalties as in case of Felony.			
10. EVERY Collector of Tolls who shall demand or take a greater Rate of Tolls than fixed by the Company, shall forfeit a Sum not exceeding	5	0	0

PENALTIES,

IMPOSED BY THE BYE-LAWS [illegible] RAILWAY COMPANY,

Made on the 10th [illegible] July, 1827.

	£.	s.	d.
1. EVERY Driver absenting himself from his Horses, Carriages, or Steam Engines, passing [illegible] negligently driving the same, shall forfeit a Sum not exceeding	0	10	0
2. EVERY Driver refusing to declare his Christian and Surname, and Place of Abode, or [illegible], when required by any Proprietor, or any Agent or Servant of the Company, shall forfeit a Sum not exceeding	2	0	0
3. ANY Person drawing off any Waggon, except at the proper Branches or Turn-out Places, [illegible]	5	0	0
4. EVERY Person passing upon the Railway with a Waggon or Waggons earlier than one Hour [illegible] later than one Hour after Sunset, without leave in writing, from the Company, or their Agents, shall forfeit a Sum not exceeding	2	0	0
5. EVERY Driver or Owner of any Waggon, the gauge of the Wheels of which not being [illegible] Inches from the Outside of the Flange of each Wheel; nor having the Tread of any Wheels less than 3 Inches, or the Axles more than 4 Feet apart from Centre to Centre, shall forfeit a Sum not exceeding	0	5	0
6. EVERY Driver or Owner of any Waggon, not having with such Waggon a proper Break to regulate the Speed thereof, shall forfeit a Sum not exceeding	2	0	0
7. EVERY Driver suffering any Coal, Stone, or other Materials, which shall fall off any Waggon under [illegible] or which he shall Teem from any such Waggon, or suffer the same to proceed from or come out of such Waggon, to remain on the said Railway, and obstruct the Passage thereof, shall forfeit a Sum not exceeding	2	0	0
8. EVERY Driver of a Waggon or Waggons, who shall not give immediate notice to one of the Company's Servants, of any Waggon passing on the Railway, having broken or displaced any Rail, shall forfeit a Sum not exceeding	2	0	0
9. EVERY Person who shall refuse to deposit any Goods or Merchandise, which shall be discharged from any Vessel, Waggon, or other Carriage, on any of the Company's Wharfs, in the place directed by the Wharfinger, or Superintendant, of the Company, shall forfeit and pay any damage or injury occasioned by such refusal, and shall also forfeit a Sum not exceeding	2	0	0
10. EVERY Owner of Coals, Lime, Minerals, Lead, Goods, or Merchandise, who shall suffer the same to remain an unreasonable time on the Railway, in the Waggons carrying or conveying the same to the inconvenience of Traders thereon, shall forfeit and pay to the Company the expense of removing such Goods or Merchandise, and also a Sum not exceeding	2	0	0
11. ANY Agent, or Toll Collector, being himself the owner of, or interested in any Waggons or Horses, or any Coach or Coaches for the conveyance of Passengers, trading or passing on the Railway, being a dealer in, or retailer of Liquors, Victuals, or any other Goods upon the Railway, without leave of the Committee or Sub-Committee, shall forfeit a Sum not exceeding	5	0	0
12. EVERY Engine-man, who shall permit any Person or Persons, except his Assistants, or the Company's Agents or Servants, to ride upon any Locomotive Engine, or any Waggon or Carriage connected therewith, shall forfeit a Sum not exceeding	0	10	0
13. EVERY Engine-man, Carriage-man, or Waggon-driver, who shall leave the Coupling Bars or connecting Chains of Waggons on any part of the Railway, except the Place or Places appointed by the Company's Engineer for leaving the same, shall forfeit a Sum not exceeding	0	10	0
14. EVERY Engine-man, Carriage-man, or Waggon-driver, leading Coals, Goods, or Materials, in the Company's Waggons, who shall suffer the Axles of such Waggons at their bearances or journals to be without Oil or Grease, shall forfeit a Sum not exceeding	1	0	0
15. EVERY Person, except the Company's Agents or Servants, who shall ride upon any Waggon or Engine, passing on the Railway, without having obtained the Licence of the Company or their Agents, shall forfeit a Sum not exceeding	0	10	0
16. EVERY Engine-man, Waggon-driver, or Coach-driver, who shall neglect to give Notice to the Company, or their Agents, of any Accident happening to any Waggon or other Carriage on the Railway, shall forfeit a Sum not exceeding	0	10	0
17. EVERY Engine-man, Waggon-driver, or Coach-driver, who shall neglect to adjust the Switches to answer the Road he shall be going, shall forfeit a Sum not exceeding	1	0	0
18. EVERY Engine-man, Waggon-driver, or Coach-driver, who shall take a Siding, and shall neglect to adjust the Switches to answer Carriages passing down the Main Line, shall forfeit a Sum not exceeding	1	0	0
19. EVERY Person who shall lay or deposit Stone, Coal, Lime, Timber, or any other Material on the Railway or Foot-paths, shall forfeit a Sum not exceeding	1	0	0
20. EVERY Owner or Driver of any Coach or other Carriage, used on the Railway, for the conveyance of Passengers, who shall refuse to conform to, or shall disobey any of the Rules, Orders, and Regulations of the Company, or their Committee or Sub-committee, relative to the Departure of any Coach or other Carriage from Darlington, Stockton, or any other Place upon the Line of the Railway, or the Standing-Place of any other Coach or Carriage, shall forfeit a sum not exceeding	2	0	0
21. EVERY Owner or Driver of any Coach or other Carriage, used on the Railway, for the Conveyance of Passengers, who shall carry, save for Passengers only, any Parcel or Package exceeding 28 lbs. weight, shall forfeit and pay a sum not exceeding	2	0	0
22. THE Captain or Captains, Owner or Owners, of part or of the whole of any Vessel or Vessels, laying to or at the Staiths, for the Shipping of Coal, Lime, and other things, at Stockton, belonging to the Company, for the purpose of taking in Coals, Lime, or other Materials, or any Material or other thing whatsoever, and causing any Damage or Injury whatsoever to the Staiths, or other erections of the Company, shall be liable to Pay to the Company the damages and expenses occasioned by such Damages or Injury, and shall forfeit and pay any sum not exceeding	2	0	0
23. EVERY Agent or Servant of the Company, who shall neglect to give immediate Notice to the Sub-committee, or one of the Clerks of the Company, of the infraction of any of the above Rules or Bye-Laws, such infraction having come to his knowledge, shall forfeit a Sum not exceeding	0	10	0

Regulations for taking the Sidings.

	£.	s.	d.
24. EVERY Person who shall travel upon the Railway with an empty Waggon or Waggons, and shall refuse to take the Passing or Siding Place, on the approach of a Loaded Waggon or Waggons, shall forfeit a Sum not exceeding	0	10	0
25. EVERY Person who shall refuse to take the Passing or Siding Place, on the approach of a Locomotive Engine, shall forfeit a Sum not exceeding	0	10	0
26. A LOADED Train of Waggons descending, meeting a Loaded Train ascending, the Loaded Train descending shall take the Siding, except when the several Waggons shall meet between Sidings, in that case the Loaded Waggons ascending shall be put back into the next Siding down the Way.			
27. ALL Empty Waggons ascending or descending shall take the Sidings nearest, on meeting Loaded Waggons.			
28. LOCOMOTIVE Engines shall be exempt from taking the Sidings, except in meeting another Locomotive Engine, in that case the Empty Train shall take the Siding			
29. A COACH, for Conveyance of Passengers, shall not take a Siding unless it shall meet a Locomotive Engine, or Loaded Train of Waggons.			
30. ALL Locomotive Engines, Waggons, and other Carriages passing along the Railway and drawing or carrying Coal, Stone, Lime, Lead, Merchandise, or other heavy Goods, shall on being overtaken by a Coach or Coaches for carrying passengers, stop at the first siding such Locomotive Engines, Waggons, and other Carriages shall arrive at, and allow such Coach or Coaches to pass, and on approaching to meet any such Coach or Coaches, all such Locomotive Engines, Waggons, and other Carriages as aforesaid, shall in all cases stop at the Siding next to the last Siding which such Coach or Coaches may be at, or shall have passed, so as to allow such Coach or Coaches to proceed.			
31. FOR every Infringement of any of the above Regulations, respecting the taking of Sidings, a Penalty shall be incurred by every Engine-man, Carriage-man, Waggon-driver, or Coach-driver, so infringing on any of the above Regulations, not exceeding	0	10	0

The old paper was worn away at the folds and had to be mounted on muslin to be preserved, and is an interesting link between the past and the present.

SUBURBAN STATIONS ON THE CENTRAL RAILROAD OF NEW JERSEY.

DURING the past few years the Central Railroad of New Jersey have been building a large number of model suburban stations, which are not only tasteful in design and of attractive appearance, but are exceptionally well arranged for accommodations of the class of traffic for which they are intended to cater. It will be remembered that in our issue for June, 1893, we illustrated a club car, which was built by the Harlan & Hollingsworth Company for this road, and which, we believe, has recently been put in service for club purposes. There are a number of these cars running from Plainfield and other points into New York on regular trains each day, and the growing suburban population, which ask for special cars, also demands something better for station accommodations than the sheds, which have been too common on the roads running out of New York and doing a commuter traffic. Of the stations which have recently been built we have selected three as being typical of the various designs presented.

The first one is that at Westfield, which is on the main line of the road; the other two are on the Long Branch Division, one at Interlaken and the other at Little Silver. The Westfield Station accommodates a larger traffic, and it will be seen from the photo-engraving published that it has a tastefully designed exterior. It is built of New Jersey light sandstone. The plan of the building, which is given on the page opposite that to the photo-engraving, shows the interior arrangement of the building: the baggage-room at one end, with a main waiting-room central, having fire-places and settees, and into which opens the telegraph and ticket-office, with a bay-window on the track side. At the end opposite to the baggage-room, and forming an end symmetrical with it, with a bay-window added, is the women's waiting-room, supplied with a handsome fireplace and ordinary accommodations. This station was designed by Messrs. Peabody & Stearns, of Boston. It is unnecessary to enter into details of the construction of the foundations and mason work, except to say that the best quality New Jersey sandstone from the Stockton quarries was used for the main walls of the building, Indiana trimming being used. All of the carving on the building is in relief work. The floor joists are supported by hard brick piers, and the chimney and fireplaces and arches are of the same material. The flues for the chimneys are lined with terra cotta lining, and the floor, fireplaces, and hearth with Pompeiian brick laid in colored mortar. The floors are laid with 1-in. thickness of hemlock flooring put on diagonally, over which a facing of Florida comb, clear-tongued and grooved, is laid. The columns supporting the roofs are of Florida heart pine. Pine is used for the doors and window-sashes, and the glass coloring of the windows is of the *ondoyant* colors, carefully selected by the architect. All the interior finishing lumber is of clear seasoned North Carolina pine, hand-planed and sand-papered with the grain, so that it could be handsomely finished in the natural state. The seats are of five-ply perforated back, with bent wood arms and nickel trimmings. The frames are of North Carolina pine. It may be interesting to note the specifications which were laid down for finishing the inside woodwork. All portions of it, except the floor, were given one coat of Rosenberg's filler and two coats of Rosenberg's elastic finish, rubbed down with hair and jute, all putty being put in so as to match the woodwork finish, while the floors were filled and given a wax finish. The building is wired for electric lights with heavy insulated wires, and the ceiling lights are lighted with through switches from the ticket-office.

The other stations—namely, Interlaken and Little Silver—are on the Long Branch Division of the road and are smaller, inasmuch as the traffic to be served at those places is very much less. The general outside appearance is clearly shown by the engraving. They are of stone, with broad covered platforms extending out on either side. The internal arrangements of Little Silver Station are shown on the engraving. There are two waiting-rooms, with a passage-way between, into which the windows from the ticket-office open. The seats run around along one side, which is the end of the building, up to the doors on either side in both rooms. There is nothing particularly novel in the internal arrangement, and the outside is the most interesting portion of the building.

The internal arrangements of the Interlaken Station is practically the same. Here as well as at the Little Silver Station, there is a *porte-cochère* on the side of the building farthest from the track, with a bay-window on the track side. It is only in slight modifications that any differences exist between the two. The general finish and construction of the two buildings are identically the same. The stones used in the construction of the main walls have split faces on the outside, and were laid up in lime and cement mortar. All of the outside finish, such as the windows and doors, and of the timber work, such as the beads, rafters, brackets, etc., are of the best hard pine, rough hewn and pinned together. The finish on the interior is the best hard pine throughout, the sheathing being of 2¼ in. strips matched and beaded. This sheathing is vertical for a height of 4 ft. above the floor, and above that it is horizontal. The joint is vertical and horizontal, the sheathing being covered with a 4-in. simple molded cap. The outside and inside woodwork being of hard pine, was given one coat of oil and two coats of hard-oil finish, the first coat being put on as soon as the finish was up. All outside and inside pine and metal work was given three coats of hard lead and oil. It will thus be seen that, while the finish and the details of these buildings do not call for any very great expense in construction, that they are exceedingly tasteful and conveniently designed, so that it would seem to take away the last excuse of those roads who build mere boxes for suburban stations, except that, of course, they are their own architects—they save these fees. But the old saying, "A man who is his own lawyer is apt to have a poor attorney," may be verily applied to the matter of architecture.

SPECIAL TOOLS OF THE PHILADELPHIA & READING RAILROAD.

TICKET-DESTROYING MACHINE.

HERETOFORE the tools and machinery which we have illustrated, as connected with or built by the shops of the railroads, have been intended solely for use in the shop, lessening the cost of labor on some special class of work. The shops of the Philadelphia & Reading Road, however, have not confined themselves to improvements within their own domain, but have built other machines which are intended for use along the line of the road or for special purposes, wherein they found that they could do this more economically than the regular builders. Among such tools is the ticket-destroying machine, of which we give complete illustrations.

The plan, side and front elevations of the machine give a very complete idea of its general construction, and it will be seen to be exceedingly simple. The idea of the machine is that the tickets to be destroyed are put into the hopper over the pair of mandrels provided with cutting teeth, and these, revolving in opposite directions, carry the tickets down in between them, and mutilate them to such an extent that it would be impossible to use them a second time, delivering them into the tin shute shown below the base of the machine, on to the floor or into a basket. It will be seen that the framework is of wood, and that the motive power is derived by a treadle driven by the foot of the operator and steadied by a heavy fly-wheel, with a belt running up to the arbor of one of the cutters. Spur-gears meshing with each other drive the second arbor, and this is practically all there is of the machine.

In order that others who may feel interested in the duplication of such a tool can do so, we have given a very complete set of measurements, that the size can be readily seen.* Of course where power is available the treadle and fly-wheel are dispensed with, and the belt will be carried down to a pulley on the main arbor from an ordinary countershaft.

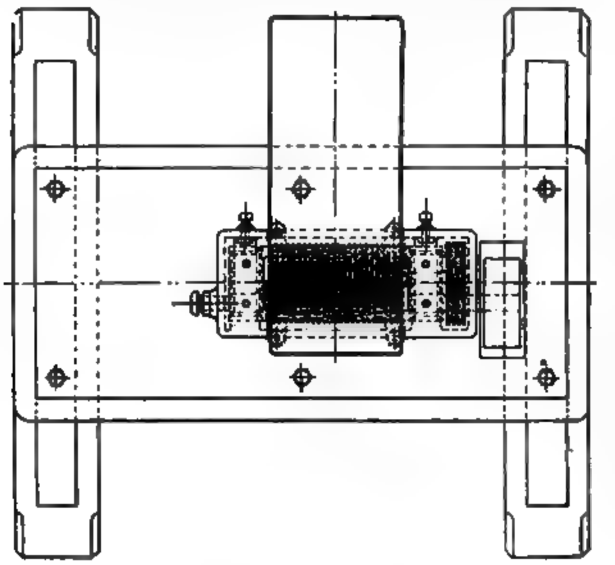
CARRIER FOR WHEEL LATHE.

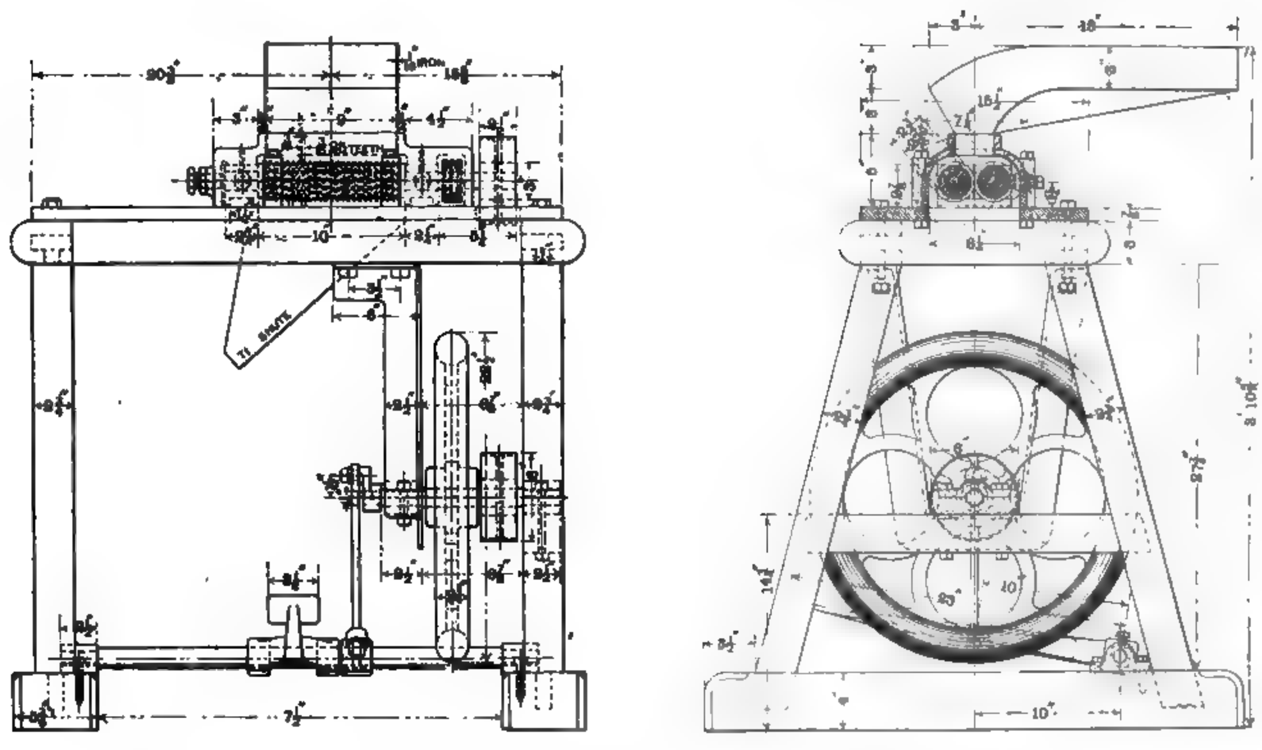
Any one who has to do with the adjustment of driving-wheels in the double-headed wheel lathe knows how difficult it is to secure an adjustment so that the bearing of each face-plate is steady and even against the wheel next to it. It is sometimes the labor of hours to get the wedges so driven that each driver is doing its own portion of the work, and that the spring of the axle is not carried from one wheel to the other, causing a chatter which renders it impossible to turn the wheel smoothly. The driver which is shown is of very simple construction, and is bolted into position on the wheel lathe through the ordinary slots with T-headed bolts, so that it has an approximate bearing. That portion of the driver which comes within the hub is eccentric with the outer part, and is of a smaller diameter, and it is, therefore, merely necessary, after an approximate adjustment has been made, to turn it until a solid bearing of the driver against the hub is obtained, and then to hold the driver in that position by the set screw shown

at the side. After starting the lathe, if it should be found that one driver is doing more work than the other, owing to the carelessness or difficulty in bringing both up to exactly the same stress of bearing, one driver can be moved ahead or the other slackened back according to the judgment of the workman.

THREE-CYLINDER ENGINE.

Most engineers are familiar with the wonderful work which has been done by the three-cylinder Brotherhood engines for high speed, which are running dynamos and other rapid running machinery direct from their own shafts. Among the





TICKET-DESTROYING MACHINE, PHILADELPHIA & READING RAILROAD.

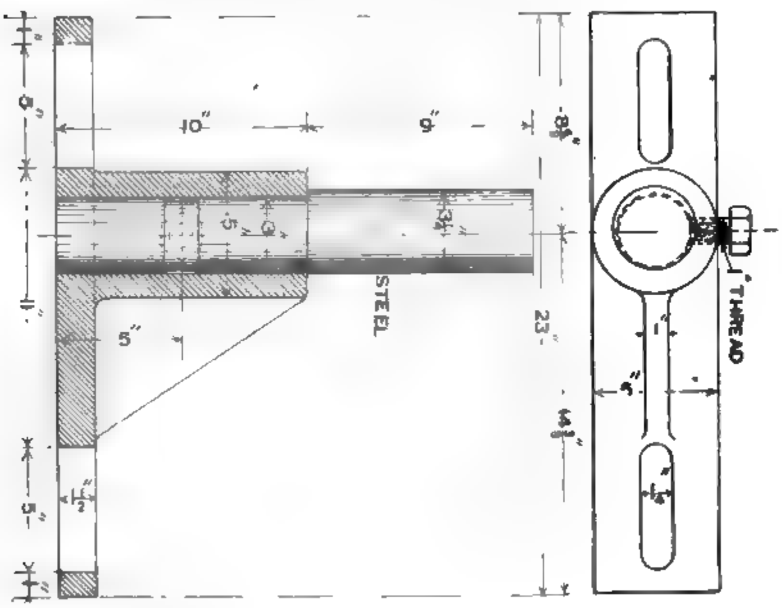
interesting little tools in the shop of the Philadelphia & Reading Road is the three-cylinder engine, of which we give illustrations. It is a single-acting engine with trunk cylinders set at an angle of 120° with each other. The cylinders have a diameter of 2 in. with a stroke of 2 in. They are lined with steel bushings, and the trunk packed with steam packing of the ordinary type. The valve is arranged at the end of the shaft, and admits and exhausts the steam consecutively from the three cylinders. This particular engine is mounted on trucks, and is carried about the shop to be used wherever steam power is desired. Among the uses to which it is put is the boring out of holes, reaming holes in frames, etc. One of them is in constant use in boring out cylinders. In all cases except the latter they are connected with Stowe flexible shafts, which in turn are connected to portable drilling or boring attachments. The engine, as will be readily seen, is simple and cheaply constructed, and is very readily handled and adapted to all the various uses of a large shop where portable power is required.

PUMP VALVES.

At a recent meeting of the Institute of Marine Engineers Mr. W. E. Lilley read a paper on "Pump Valves."

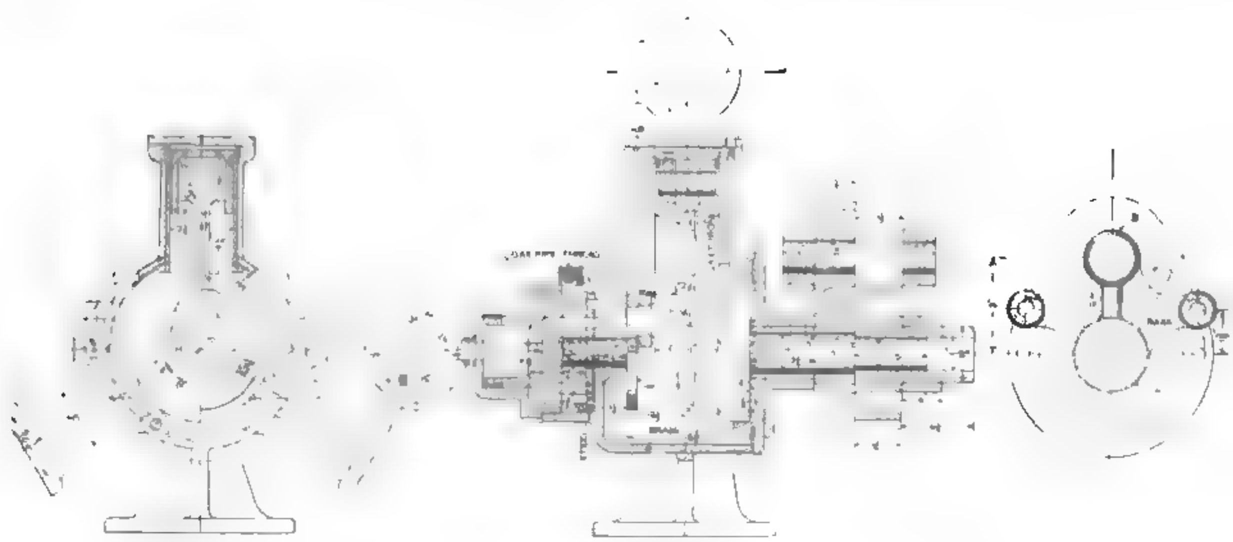
Mr. Lilley said that the subject of his paper, usually considered an elementary one, was, however, of much interest, and worthy of the consideration of engineers, who found that it was rather by attention to detail than to any radical change in the design of the engine itself that the highest efficiency was obtained. Pumps being a necessary adjunct to every condensing engine, and absorbing, as they did, a large amount of mechanical power, engineers naturally endeavored to reduce the loss under this head to a minimum. To obtain this result it was necessary to consider the pump valves, which had so much to do with the efficiency of the pumps. To determine, then, what was the best style of valves for a pump, it was necessary to consider what was required of the pump, and what were the conditions under which it had to work. First he would deal with the different kinds of pumps. In this paper reciprocating pumps had been classed as follows: 1. Plunger pumps, such as feed pumps; 2. Piston or double-acting pumps, such as combined steam pumps and some forms of circulating pumps; and 3. Bucket pumps as generally used for air and circulating pumps. Among other desiderata required for pumps, the following were practically general for all; they should have a good efficiency under varying conditions of speed and work; they should run free from noise and shocks, and require few repairs. Water in all cases had been assumed as the liquid to be pumped, its viscosity being neglected. Referring to the piston pump, a drawing of which was given with the paper, the author said that the piston speed in feet per minute would be equal to the stroke in feet multiplied by the number of strokes per minute. This was the average piston speed, if the piston was supposed to be

connected similarly as the steam piston was to a shaft rotating uniformly. The speed would vary from nothing at the commencement of the stroke to a maximum toward the middle of the stroke, and this maximum could be shown to be approximately half as much again as the average speed. The above applied equally to plunger or bucket pumps. Calling attention to drawings of a piston and a plunger pump, Mr. Lilley said that if the valves were supposed to be arranged as there shown, and the stroke just commencing, water would flow into the pump tanks to the difference of pressure in the pump chambers and the outside source of supply. Similarly on the



CARRIER FOR WHEEL LATHE, PHILADELPHIA & READING RAILROAD.

return stroke, water flowed out of the pump due to the difference of pressure in the pump chamber and the vessel into which it delivered. This volume of water was then set in motion in opposite directions every double stroke. Should the valves be at some distance from the pump chamber, a volume of water in the passages was also set in motion in opposite directions every double stroke, and this to no useful purpose. To avoid this it was advisable, and might also be



THREE-CYLINDER ENGINE, PHILADELPHIA & READING RAILROAD.

stated as an axiom, that there should be as little clearance as possible between the pump chamber and the valves. Some objections might be raised that the water exterior to the pump had also to be set in motion, and that the closeness of the valves was not of such consideration. To overcome this it was usual to fit air vessels close to the valves, or to arrange that the water in the supply and delivery should be continually flowing toward and from the pump chamber respectively, the object in both cases being to give motion to as small a quantity of water as possible, beyond that required by the pump at each stroke. Another reason for having as little clearance as possible, which was specially applicable to air pumps, was that the clearance space, by allowing vapor to form, caused the efficiency of the pumps to be impaired. The positions of the valves with regard to the pump chamber might be multiplied almost indefinitely, and dependent in a great measure on the position of the pump itself, the valves being usually arranged so that their own weight helped to close them. Some pumps were made with a pump chamber of larger size than the plunger, so that a volume of idle water was in the pump. By this means it was possible to overcome the objections of having a volume of water reciprocating to and fro in the passages, and at the same time secure favorable positions and plenty of space for the valves which could be arranged on the pump chamber itself. The disadvantage this had was that in pumping hot water, if the difference of pressure between the pump chamber and the supply or delivery was appreciable, vapor was formed and impaired the efficiency of the pump. In reciprocating piston and plunger pumps the continual change of direction of the water in and out of the pump chamber acted disadvantageously against any great piston speed. If the piston in the drawing of the piston pump be supposed to be moving with a quick speed, the difference of pressure between the pump chamber and the outside source of supply would be greater than if it were moving with a slow speed. This difference of pressure would vary approximately as the square of the speed. The water, owing to its inertia, would also have to be acted upon for an appreciable time by this difference of pressure, to give it the required velocity of flow into the pump chamber. Suppose, then, the piston speed to be continually increased, a speed would be arrived at in which the pump chamber would be only partially filled with water, the water not having time to acquire sufficient velocity to follow the piston. Suppose such a case to have happened, that the pump chamber was about half filled with water on the return stroke, the piston descended and met the water, it would at this moment have its maximum velocity during the stroke, and all the water in the pump chamber would have to acquire this velocity instantaneously, together with the pressure necessary to drive it through the valves into the delivery. Something, then, in the nature of a blow would take place, and it was due to this cause that the difficulty of making high-speed piston pumps arose, the strains on the working parts being largely increased as the speed increased, and the pump falling off in efficiency. Bucket pumps had a great advantage as

compared with piston or plunger pumps in this respect. The direction of the flow never changed, and the difference of pressure required was only that necessary to drive the water through the valves. Supposing a similar case to occur as in the piston pump, that the pump chamber was only half filled with water, on the bucket meeting the water only the surface of the water was affected, thus relieving the pump and permitting of a more efficient pump at high piston speeds. Having thus briefly determined the working of the pump, the best conditions for the pump valves would now be considered. The area through the valve-seat should be as large as possible. Various authorities gave the velocity of flow through the valves from 400 ft. to 600 ft. per minute, which corresponded to a difference of pressure from 1 lb. to 2 lbs. between the pump chamber and the source of supply or delivery. In designing the area through the valve-seats the conditions under which the pump would be required to work must be considered, since for the water to flow into the pump an amount of energy had to be expended in giving the necessary velocity to the water to flow into the pump, and this energy expended varied as the square of the velocity. If the strokes per minute were constant, the expended energy would also have to be given to the water in equal times. It followed that the difference of pressure would vary as the square of the velocity. From this, then, it would be evident that in fast running pumps the area through the valves should be as large as possible. The area through the opening due to the lift of the valves should be equal to the area through the valve-seats. This might almost be said to be self-evident, and yet it was one of those things most overlooked in pumps, the lift, as a rule, not being sufficient. The real area through the valves in this case was the opening through the lift of the valves, and the area of the valve-seat might be reduced to that area without throwing any more work on the pump. The valves should always be as light as possible. Referring to the drawing of the piston pump, if the piston be supposed to be just at the commencement of the stroke, the delivery valve closed, and the suction-valve just upon opening, it would require a certain amount of energy to move the valve off the seat. A small portion of the stroke would take place before there was any motion of the valve; then, owing to the increasing difference of pressure, the valve moved with an increasing velocity till it met the stops, giving up its energy of velocity in striking the stop. This kinetic energy would be proportional to the weight of the valve and to the square of the velocity. Similarly on the down stroke the valve closed, striking the seat, but in this case its kinetic energy might be greater, owing to the fact that the pressure in the pump chamber rapidly augmented to drive the water through the delivery valve, and the action of the delivery valve would be precisely the same. If, then, the valve be heavy, it followed that the wear and tear due to hammering or striking would be great, also that the valve itself would be sluggish, owing to its inertia. To avoid this, then, the valves should be as light as possible. The lift of the valves should be small. Suppose a pump having valves whose weights were the same, but one valve with twice the lift of the others, the valve with the greater lift would have the greater velocity on striking the stop or valve-seat, and its kinetic energy would be approximately twice as much as the one with the smaller lift. It was also important for the valves to open and close quickly, and the less the lift the better would these conditions be satisfied. The diameter of the valves should be small, annular, or the equivalent of having several small valves in one. The area of the valve-seat varied as the square of the diameter, while the lift of the valve remaining the same, the area of the opening varied as the diameter only. Therefore if the diameter of the valve be doubled it was necessary to double the lift. The above conditions gave some guide in determining the best forms for valves, but much was still left to the discretion of the designer in choosing that valve which would give the best results according to the conditions under which the pumps would have to work. The plethora of good valves now before the public, each having some special merit, made the choice of the one to be selected for a particular purpose one of great nicety and discrimination. The pioneer engineers in the early days of steam used leather valves, commonly known as the flap or butterfly valves. These then gave way to metal flap valves, the idea of the flap seeming obviously to have been taken from the leather valves then in use, and no doubt these valves worked well in the days of low pressure and slow piston speeds. The rubber valves were next introduced, and so long as they had not to pump against any great pressure, and were kept free from oil, left little to be desired in their working, even to the present time holding their own in circulating and such like pumps. Oil having a solvent action on the rubber, they were found to rapidly deteriorate in the air pumps. Attempts had been made to make the rubber impervious to oil, but up to the present unsuccessfully. Vulcanite, a hardened preparation of rubber, fiber, asbestos, cast-metal valves of various types, and thin rolled phosphor bronze sheets followed, the tendency being as the piston speeds and pressures kept on increasing for the valves to be lighter and of stronger section. The author then proceeded to refer in detail to the special features of the best-known valves now in use, and, in conclusion, said he hoped that members would contribute particulars of any further valves which might not have been mentioned, so that the information furnished as to available pump valves might fairly cover the ground as represented by modern practice.

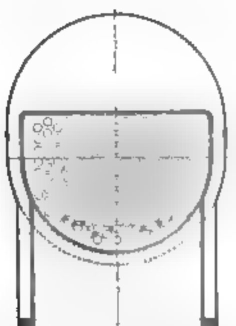


Fig. 1.

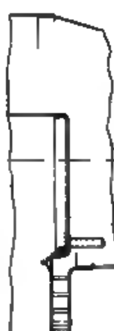


Fig. 2.

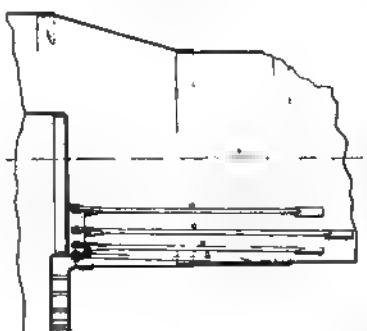


Fig. 3.

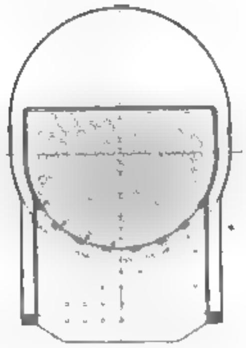


Fig. 4.


Fig. 5.

DIAGRAM OF CRACKS IN FIRE-BOX SHEETS.

CRACKS IN FIRE-BOX SHEETS.

At a recent meeting of one of the committees of the Master Mechanics' Association, Mr. David Brown, who is Master Mechanic of the Delaware, Lackawanna & Western Railroad Company, at Scranton, Pa., submitted a drawing showing the sections of boiler and fire-box, and points upon it marked that were most liable to crack and bulge. This drawing we reproduce in our engravings, and would call attention to the fact that it contains a modification of the ordinary form of boiler construction which has been adopted by Mr. Brown, for the purpose of overcoming the difficulties which are most common with the locomotive form of boiler. Fig. 1 shows a cross-section through the fire-box of a boiler, and the points in flue-sheet marked *A* are those points which are most likely to crack. This flue-sheet is shown without any bracing, and a longitudinal section of the same is given in fig. 2, showing how likely it is to be sprung by expansion at the point *B*. It does not necessarily follow that the bulge and deformation shall be as great relatively to the rest of the boiler as it is shown here, but the tendency is as represented. Fig. 3 shows a design of flue sheet which Mr. Brown is using, and which is intended to prevent the springing illustrated in fig. 2.

It will be seen that the lower portion of the front sheet has the flange carried back beyond the face of the tube-sheet, and to this the braces *C* are pinned with their other ends riveted to the sheet of the boiler.

The cross section of the same boiler is shown in fig. 4. The

points marked *D* being the attaching points to the flue-sheet, eight of these are used and the trouble is practically overcome. It will be seen that with the ordinary fire box, as shown in fig. 2, the distance between the top stay-bolt in the front flue-sheet and the bottom tube is considerable, and that as the tube is held by the friction of the expanded portion and the bead, the strain at that point must be far greater than that which should, in good practice, be put upon the tube. By distributing these stays along the bottom of the sheet, as we have shown them, the strain on the tube-sheet is brought down to the normal point. The additional expense of doing this work is simply that involved in the making of the braces and putting them in position, for no more iron would be required for the deep flange, as shown on the improvement, than on the old, except that there would be a little less scrap left from the sheet.

Fig. 5 gives a partial outside view of the throat-sheet, showing the cracks about the upper stay-bolts *F*, which are caused by the strain on the sheets when the braces at *D* are not used. Every master mechanic knows the trouble which he has with leaky throat-sheets, and the cracks which are so liable to form around the upper stay-bolts, so that the braces which are used here serve the double purpose, not only of preventing the tube-sheet from becoming distorted and cracked, but also protects the throat-sheet from the annoying cracks that are likely to appear around the upper stay-bolts.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.

SECOND SERIES.—CHEMICAL METHODS.

VI.—METHOD OF DETERMINING PHOSPHORUS IN PHOSPHOR BRONZE.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(*Continued from page 578, Volume LXVII.*)

OPERATION.

Put 1 gram of fine borings in a beaker about 2½ in. in diameter by 3½ in. high, and add 25 c.c. of aqua regia. Cover the beaker and allow to dissolve; then heat to near boiling point of the solution for half an hour. Add 25 c.c. of distilled water and then 20 c.c. of concentrated C. P. ammonia, specific gravity 0.90. Then add 50 c.c. of ammonium sulphide. The principal portion of the copper and lead is precipitated as sulphides, and the tin and phosphoric acid are in solution, which is a clear yellow. Digest at a temperature near the boiling point of the solution for 20 minutes. Allow to settle, then filter through a 9-cm. filter into an Erlenmeyer flask, holding about 300 c.c. The filtration and washing is best managed as follows: Pour the clear liquid on the filter, and allow most of it to run through. Then pour the remaining liquid along with the precipitate on the filter, and allow everything that will to run through. Put the filter with the precipitate on it back into the beaker, and add 50 c.c. of the ammonium sulphide wash water. Warm and stir occasionally for 10 minutes to secure as complete solution and diffusion of the soluble material as possible; then pour everything on another filter and allow all that will to run through. Then wash on the filter with about 50 c.c. more of the ammonium sulphide wash water. This gives a volume of filtrate of about 200 c.c. Add now to this filtrate 10 c.c. of magnesia mixture, and shake to secure uniform diffusion of the precipitant. Put the flask in ice water and allow to stand in same with occasional agitation for two hours. Filter through a 7-cm. filter, and wash with ammonia wash water only until the washings react slightly with silver nitrate. Then add 10 c.c. of dilute hydrochloric acid to the flask, and so manipulate that the liquid touches all parts of the inside of the flask and dissolves any adhering precipitate. Then with the liquid in the flask dissolve the precipitate on the filter, allowing the solution to run into a small beaker. Wash the flask and filter with the same dilute hydrochloric acid until the volume of the filtrate is about 30 c.c. Add now 5 c.c. of magnesia mixture and 10 c.c. of concentrated C. P. ammonia 0.90 specific gravity; agitate by stirring, put in ice water, and allow to stand with occasional stirring for two hours. Filter on a 5 cm. filter, wash with same ammonia wash water, until the washings react only slightly opalescent with silver nitrate. Smoke off the filter, ignite until the precipitate is white, and weigh.

APPARATUS AND REAGENTS.

The apparatus required by this method needs no special comment.

The aqua regia is made of equal parts nitric and hydrochloric acid by volume, both concentrated C. P.

The C. P. ammonia is obtained in the market, specific gravity 0.90.

The ammonium sulphide solution is made by treating C. P. ammonia, specific gravity 0.90, with H_2S until no further absorption takes place, and then adding two-thirds as much by volume of the same ammonia to the solution. It is only slightly yellow in color, and may usually be obtained in the market.

The ammonium sulphide wash water is made by adding three parts of distilled water to one part of the above solution, both by volume.

The magnesia mixture is made by dissolving 66 grams of crystallized C. P. magnesium chloride and 168 grams of C. P. ammonium chloride in 780 c.c. of distilled water, and adding 420 c.c. of C. P. ammonia, specific gravity 0.96. Allow to stand two days and filter.

The ammonia wash water is made by adding to 800 c.c. of distilled water 200 c.c. of C. P. ammonia, specific gravity 0.90, and 25 grams of crystalized C. P. ammonium nitrate. Filter before using.

The dilute hydrochloric acid is made by adding 1 part concentrated C. P. acid, specific gravity 1.20, to 4 parts distilled water, both by volume.

CALCULATIONS.

The atomic weights used are magnesium, 24; phosphorus, 31; oxygen, 16. The molecular formula of magnesium pyrophosphate used is $Mg_2P_2O_7$.

Since 27.93 per cent. of the magnesium pyrophosphate is phosphorus, the amount of phosphorus in the precipitate may be obtained by the proportion $a : b :: 0.2793 : x$, in which a represents the amount of phosphor-bronze taken to start with, expressed in grams; b, the magnesium pyrophosphate obtained, also expressed in grams; and x the phosphorus sought, which will likewise be in grams. Then, since the above proportion gives the actual amount of phosphorus in 1 gram or part of phosphor bronze, it is obvious that the per cent. of phosphorus—that is, the amount in 100 grams or parts, will be 100 times this amount. Where 1 gram is taken to start with, the following brief rule may be used: Express the weight of magnesium pyrophosphate found in grams, move the decimal point two places to the right, and multiply by the decimal 0.2793. Thus if the magnesium phyrophosphate found is 0.0304 gram, the per cent. of phosphorus is (3.04 × 0 2793) 0.849 per cent.

NOTES AND PRECAUTIONS.

It will be observed that this method oxidizes the phosphorus by means of nitric acid, with hydrochloric acid present to hold up the tin; separates the phosphoric acid from the lead and copper by means of ammonium sulphide, and precipitates the phosphoric acid as ammonium magnesium phosphate in presence of tin and ammonium sulphides, the precipitate being purified by a second precipitation before weighing.

The aqua regia used contains more nitric acid than is customary for this reagent. Nitric acid alone would possibly be as good or perhaps better to oxidize the phosphorus, but experience shows that the meta-stannic acid formed when nitric acid alone is used dissolves in the ammonium sulphide with some difficulty. Incomplete solution would of course result in loss of phosphorus. Accordingly some hydrochloric acid is used to bring the tin into solution. With the method as recommended, there is no difficulty with the tin.

Heating the aqua regia solution for half an hour after the metal is in solution secures complete oxidation of the phosphorus, and the addition of the water dilutes the acid sufficiently so that the strong ammonia can be added without too violent reaction.

If the ammonium sulphide used is made as recommended, very little if any of the copper sulphide is dissolved. Strong yellow sulphide of ammonium gives more difficulty from this cause; and if the yellow sulphide is used, the first ammonium magnesium phosphate precipitate may be contaminated with copper sulphide, which has separated during the two hours in the ice water. This copper sulphide may not cause subsequent difficulty, but it is better not to have it present.

The 20 minutes' digestion after the ammonium sulphide is added, and the filtration and washing recommended, success-

fully remove the phosphorus from the lead and copper sulphides. An examination of these sulphides by decomposing them with nitric acid, separation of the lead as sulphate, then separation of the copper as sulphide in acid solution by means of H_2S after partial neutralization of the free acid with ammonia, concentration of the filtrate to small bulk, and testing with molybdate of ammonia solution shows only a trace of yellow precipitate.

It is desirable to have the bulk of solution in which to precipitate the phosphoric acid by magnesia mixture as small as may be, on account of the possible solubility of this precipitate. At the same time the lead and copper sulphides are so gelatinous that complete washing on the filter is difficult. The procedure recommended apparently secures the result desired with the least amount of wash water. The following experiment has been made on this point. When the ammonium sulphide solution is ready to filter, the total bulk due to reagents added should be 120 c.c.; but on account of evaporation and decompositions the actual bulk was 109 c.c. Of this 101 c.c. ran through the filter after the clear liquid and precipitate had been put on the filter as directed. After putting the precipitate and filter back into the beaker, adding 50 c.c. of ammonium sulphide wash water, and digesting covered for 10 minutes, the bulk of solution, including the filter, was 59 c.c. Of this 48 c.c. ran through the second filter. Neglecting the volume of the precipitate, and assuming that the phosphoric acid is uniformly disseminated in the liquid, it is evident that eight one hundred and ninths of the phosphorus is left behind after the first filtration and eleven fifty-ninths of this after the second filtration. Reducing these fractions, it appears that after all that will has run through the second filter, only 1.37 per cent. of the phosphorus is left behind. As phosphor-bronze usually contains less than 1.00 per cent. of phosphorus, it is obvious that only about one hundredth of a per cent. of phosphorus remains to be washed out. The 50 c.c. of wash water recommended is apparently abundant for this purpose. In the above experiment the measurements, when the precipitate was present, were made in the beaker, and must be regarded as close approximations only.

The use of a flask for the first precipitation offers some advantages over a beaker, the principal one being that the ammonium sulphide is less exposed to the air, and consequently undergoes less change, with resulting less probability of throwing down free sulphur or traces of sulphide of copper than if a beaker is used. The flask should be covered with a small watch glass, but it is not necessary to use a cork or a glass rod for stirring.

Over-washing of the ammonium magnesium phosphate is to be avoided as carefully as under-washing. The directions given should be closely followed.

The precipitation of the phosphoric acid by excess of magnesia mixture, in presence of the tin and ammonium sulphides, seems to be fully as satisfactory as in the presence of chloride of ammonium alone. An examination of the filtrate and washings from the first precipitation by evaporation nearly to dryness, taking up with nitric acid with just enough hydrochloric to hold up the tin, and testing with molybdate solution, shows only a trace of yellow precipitate.

It is not advisable to weigh without the second precipitation. Although careful manipulation and the use of almost colorless ammonium sulphide may avoid contamination from copper sulphide, there is always danger of free sulphur in the ammonium magnesium phosphate. For good work the second precipitation should never be omitted.

Ammonium magnesium phosphate is liable to be reduced during the ignition of the filter, and thus lead to slightly low results. To obviate this difficulty, the filter and precipitate are put into the crucible wet, and the filter "smoked off" and then burned. The "smoking off" consists in applying the heat to the wet material in the crucible so slowly that the volatile matter of the filter passes off without ignition, free access of air being maintained at the same time. To accomplish this, fold up the wet filter with the precipitate in it, and place it in the crucible. Put the crucible on the triangle as in ordinary ignitions, and leave the cover off. Then heat the open end of the crucible slowly. The filter and precipitate gradually dry, and soon the parts of the filter in contact with the crucible begin to distill off the volatile matter at low heat, even before the whole is dry. This process goes on if the flame is properly adjusted, until in a little while everything that is volatile at a low temperature has passed away, and the precipitate, with a black envelop of carbonaceous matter, is left. When this is the case the temperature can be raised, the lamp moved back to heat the bottom of the crucible, and the carbon burned off completely. Usually when the temperature is raised, the black envelop of carbonaceous matter falls away from the precipitate and is rapidly consumed. By this method of ignition the material is a little longer time in the crucible than with the old method of previously dried precipitates, but the danger of reducing the precipitate is believed to be very much diminished. The small amount of nitrate of ammonia in the ammonia wash water left in the filter paper facilitates this operation.

When a bronze contains only small amounts of phosphorus, it is advisable to start with 2 to 5 grams. The manipulation and proportions of reagents are, however, the same except that 75 c.c. of ammonium sulphide should be used for the first addition, and 75 c.c. of ammonium sulphide wash water for the second addition, and about 100 c.c. of the same wash water for washing on the filter. This gives a bulk of about 300 c.c. for the first precipitation.

It seems probable that the method described above in careful hands will give results accurate to about one hundredth of a per cent., although it is not rare that duplicate determinations on the same sample differ two hundredths. Where proper care is given to each point, it takes about seven hours to get a result.

MORE ROOM NEEDED.*

Secretaries of the Interior and Commissioners of Patents again and again have given voice to the crying need for more breathing space for the men and women who work in the Patent Office; and however much of sameness it may entail, an ever-present menace to the health and safety of these people makes the imperative duty of this report to present this matter again and first of all. On high authority an office occupant needs 4,000 cub. ft. of air space in a room having "ordinary ventilation," which he occupies two successive hours. Two hundred and seventy people in the examining force of this Bureau have but 900 ft. of air space each, in rooms which they occupy for seven consecutive hours, and 110 persons in the assignment and draftsman's divisions have less than 500 ft. of air space each, in rooms which they occupy for the same length of time, and the ventilation is not "ordinary;" it does not rise to that dignity.

Originally the corridors in the Patent Office building ran to the exterior walls, where there are windows admitting light and air; but supposed necessity has since located a room at each extremity, converting the corridors into dead-air spaces, needing artificial light at noonday. The corridor-walls are lined on both sides with unsightly wooden closets and file-cases filled with record-papers. A great number of the force work in basement and sub-basement rooms, intended simply for storage purposes in the original planning of the building.

There are stored more than 1,000 tons of copies of patents on five different floors, tucked into every nook and corner where an eager eye can discover a few feet of available space, so disconnected in order and arrangement that it not infrequently happens that, to select two copies standing next each other in number, one must travel from the sub-basement to the galleries, four stories above. These copies are stored upon these galleries beyond the limit of safety, the worst overloading being directly over the Commissioner's room, and in that near vicinity the cracking of the roof-supports gives daily evidence of the danger which constantly threatens all below.

The situation is serious. It is one which in reason demands immediate relief. The present Secretary of the Interior, commenting in appreciative and generous phrase upon this matter in his letter to the President of the Senate, dated March 18, 1892, says:

> It is imperatively necessary that the Department of the Interior should be granted a public building in which to do its works and preserve its archives commensurate with the important service demanded and the great national services devolved upon it. As it is, burdens of material are not only heaped upon the buildings the Department occupies beyond their strength, but burdens of labor are imposed upon the officials, without regard to human endurance.

It would seem that no reasonable question can be made but that the permanent solution of the difficulty is thus correctly stated; but the Patent Office ought to have relief meanwhile. The immediate relief which is possible, and which Congress has apparently approved in the past, is the present and entire removal of the General Land Office from the structure commonly known as "the Patent Office building."

By act approved March 3, 1887, it was enacted:

> That as soon as practicable after the completion as provided for in the sundry civil act approved August fourth, eighteen hundred and eighty-six, and not later than December first, eighteen hundred and eighty-eight, the Secretary of the Interior shall cause to be removed to the Pension Building the General Land Office, Bureau of Education, Office of Commissioner of

* Report of the Commissioner of Patents for 1892.

Railroads, and Bureau of Labor, and vacate the buildings rented for and now occupied by said offices and Bureaus, or portions thereof.

But under the act approved October 2, 1888, it was

Provided further, That so much of the act approved March third, eighteen hundred and eighty-seven, as requires the removal of the General Land Office and the Bureau of Education to said Pension Building be, and the same is hereby repealed.

Congress, however, said this by act approved March 3, 1891 :

For rent of buildings for the Department of the Interior—namely, for the Bureau of Education, four thousand dollars; Geological Survey, ten thousand dollars; Indian Office, six thousand dollars; General Land Office, sixteen thousand dollars; in all thirty-six thousand dollars.

It is understood that less than $5,000 of the $16,000 thus appropriated for the rent of the General Land Office was used.

Congress shall have power . . . to promote the progress of science and useful arts by securing for limited times to . . . inventors the exclusive right to their . . . discoveries.

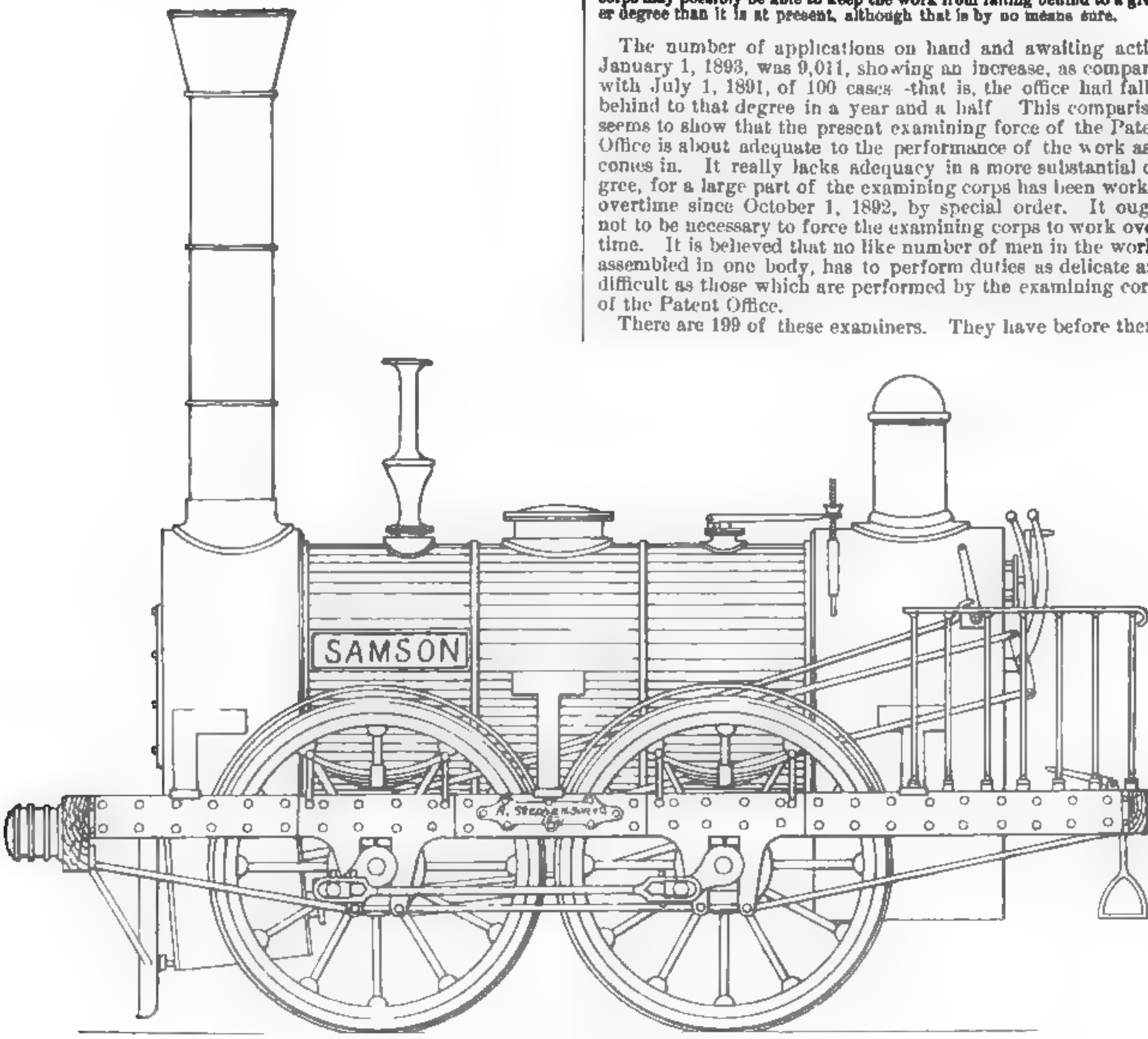
MORE FORCE NEEDED.

The number of applications for patent on hand and awaiting action July 1, 1890, was 6,585 ; the number July 1, 1891, was 8,911. During that year the work fell behind 2,326 cases. At the latter date 10 persons were added to the examining corps and four persons to the clerical force. The present Commissioner began his duties August 1, 1891. His last annual report—that for the year ending December 31, 1891—said :

Within the latter half of the year just passed ten persons have been added to the examining corps and four persons to the clerical force of the Patent Office, under provision made for that purpose by the last Congress, and that addition is a most grateful one. But it is not all that is needed. The experience of the last few months shows that the present examining corps may possibly be able to keep the work from falling behind to a greater degree than it is at present, although that is by no means sure.

The number of applications on hand and awaiting action January 1, 1893, was 9,011, showing an increase, as compared with July 1, 1891, of 100 cases—that is, the office had fallen behind to that degree in a year and a half. This comparison seems to show that the present examining force of the Patent Office is about adequate to the performance of the work as it comes in. It really lacks adequacy in a more substantial degree, for a large part of the examining corps has been worked overtime since October 1, 1892, by special order. It ought not to be necessary to force the examining corps to work overtime. It is believed that no like number of men in the world, assembled in one body, has to perform duties as delicate and difficult as those which are performed by the examining corps of the Patent Office.

There are 199 of these examiners. They have before them,



LOCOMOTIVE FOR THE MANCHESTER & LIVERPOOL RAILWAY.

BUILT IN 1831 BY R. STEPHENSON & CO., NEWCASTLE-ON-TYNE.

Now that the business of the Land Office is radically diminishing, and in the nature of things must soon become a small matter and so remain, while the business of the Patent Office steadily increases and must continue so to do, the attention of Congress is earnestly called to this mode of relieving the Patent Office from its great trouble. In this connection it is fair to say that the entire structure now occupied in part by the Patent Office was planned as a Patent Office, and its construction begun under an act approved July 4, 1836. Hundreds of thousands of dollars of patent fees have been incorporated into that building, and inventors have now lying in the United States Treasury more than $4,000,000, not raised under the taxing power of Congress, but realized under that clause of the Constitution which says that—

in round numbers, 40,000 applications for patent a year, on which are made something over 145,000 separate actions, giving each examiner an average of 730 actions on applications made yearly. In addition to this, they hear and decide a variety of motions, chief among them those for dissolution of interferences, which are argued by counsel, *pro* and *con*, and which require the same study, thought, and deliberation for proper decision as a case in a court of law. They make answers to interlocutory appeals and to appeals on the merits. The principal examiners keep the efficiency records of their divisions, and they keep the data for and render a number of reports. There is a variety of duties performed by the examiners outside of the regular actions on the applications for patents. The United States Supreme Court has repeatedly

spoken of patent law as the "metaphysics of the law," and that it is. A competent examiner must possess a wide range of scientific and technical knowledge, a trained capacity for analysis and comparison of mechanism, a fair knowledge of law in general, and a thorough knowledge of that patent law which the Supreme Court says is the "metaphysics of the law." The code of procedure and practice in the Patent Office is more complicated than that of any court of law, and necessarily so. The necessity inheres in the nature of the work. It is a pleasure to be able to say that the great majority of the examiners in the Patent Office are competent, and to repeat the statement that it is believed that there is no similar number of men in the world, gathered into one body, performing duties as delicate and difficult as those performed by the examining corps of the Patent Office. Men who do work of this character ought not to be obliged to work overtime. Experience in various fields of mental labor has shown that 90 per cent. of all errors are made after five hours of continuous work. The examiners ought to have ample opportunity for thought and deliberation, and the pace asked of them ought to be one that can be reasonably kept from day to day and year to year. Moreover, their salaries, fixed at their present figure a generation ago, should be properly increased.

Something important remains to be said. At the close of the calendar year 1891 the Patent Office had issued 476,271 mechanical patents, constituting a vast field, some particular lines in which have to be explored from first to last in connection with every one of the 40,000 applications for patent which are made each year. At the close of the calendar year 1892 the Patent Office had issued 498,932 patents. Twenty-three thousand new patents are added to this vast field of exploration yearly.

In order to make this exploration possible, the patents are divided into classes. But the classes necessarily so overlap each other that each class needs to be digested by itself, so that each examiner, in passing upon the novelty of an improvement presented for patent, can examine all the classes where he is at all likely to find the improvement in question. Let this proposition be illustrated: One of the examiners of the office, as a matter of private enterprise, lately prepared and published a digest of cycles and velocipedes, making 1,503 pages, contained in two volumes. Under the classification of the office all these improvements are supposed to be found in the sub-classes of Velocipedes and Tires, which are a part of the division of Carriage and Wagons. In order, however, to perfect a compilation, the examiner found it necessary to read from 150,000 to 200,000 patents; comprised in 150 other sub-classes he found devices which it was necessary to include in his digest. Only two or three such digests exist, and they are the product of private enterprise. If all the classes of invention were thus digested, the work of examination into novelty would be wonderfully facilitated, and at the same time made more thorough than is now possible. The situation is such as to demand the making of these digests. It is earnestly recommended that 32 additional fourth assistant examiners (one for each division) be authorized by law expressly for this work; that 16 additional fourth assistant examiners be authorized for the purpose of bringing the current work up to date and keeping it there, and that $25,000 of annual appropriation be made to begin the publication of the digest.

FOR THE GOOD OF THE NATION.

It would almost seem as if there were a halt in the workings of that practical wisdom with which the nation has hitherto treated its inventors. The fathers who builded the Constitution with such rare foresight as to compel the admiration of the world in ever-enlarging degree as we recede from the day in which they wrought, gave Congress the power to promote the progress of the useful arts by securing to inventors for limited times the exclusive rights to their discoveries. The Congress of 1790 promptly made a patent law in pursuance of that power. The Congress of 1793 revised it. The Congress of 1836 broadened the foundations of the system, created the Commissioner of Patents, and ordered the building of the Patent Office, substantially as it now exists. The Congresses of 1842, 1861 and 1870 added features of improvement.

The results have more than justified the constitutional provision and the legislation following in its wake. America has become known the world around as the home of invention. We march in the van of human progress. Now and then a great invention, like the telegraph or the telephone, leaps ahead of the line, but thousands upon thousands of busy inventive brains add each its mite of improvement, and before we know it the whole line has moved out to where the product of mighty genius but a little while ago stood alone. A vastly larger number of inventions are of real value than the great public dreams, and those which seem to fall dead contain within them the seed of suggestion which later lives and grows to rich fruition. There is a sad procession of martyrs mingled with the great inventive host, but the country and the world profit by their sacrifice.

Our inventors are the true nation builders, the true promoters of civilization. They take nothing from the public; they ask nothing from the public; they simply add to the sum of human knowledge, to the sum of human possessions, and to the sum of human happiness. With the Ruler of the universe they share in humble degree His high prerogative of creation, and they but ask to enjoy for a little time the use of the valuable thing they create. The Greeks reserved their highest honors for inventors, and we shall sometime attain to a civilization of like degree.

Into every department of industry and into every possible thing that can conduce to human comfort American inventive genius has entered, to cheapen and to beautify. The Western farmer may know it not, but the inventor of the compound marine engine is possibly the best friend he ever had, and that farmer will find his reward in ascertaining for himself what its effect in cheapening transportation across the ocean has been upon his fortunes. Another example: a single generation ago our carpets were made for us by foreign hands, and the prices were excessive. A great American inventor produced the Bigelow carpet-loom; building upon the faith of an American patent, $1,000,000 in one instance and $1,500,000 in another were risked upon the experiment. The result to day is that our carpets cost about one-third of what they did, and less than one-hundredth of them are made by foreign looms. Had there been no patent law, these millions would never have been risked in the experiment so rich in result to the American people. If to-day the sewing-machine were produced for the first time and we had no patent law, its inventor would hawk it in vain up and down the land to find that foolish man who would risk $500,000 in its commercial development, with the certainty that success would but invite a ruinous competition.

If there be one class of men above all others to whom the American nation and the American people are in debt, it is the American inventors. Why not grant them the poor boon of expending for their benefit the moneys they pay?

LOCOMOTIVE "SAMSON."

We are indebted to Mr. Clement E. Stretton for a blue-print, from which the accompanying engraving was made. This engine was built for the Liverpool & Manchester Railway in 1831 by Robert Stephenson & Co., of Newcastle, and, as Mr. Stretton says, "was just like many sent to America in 1831." Its resemblance to some of the historic locomotives in this country will be recognized. Its cylinders were 14 × 16 in., and the wheels 4 ft. 6 in. diameter.

It is not generally known how many locomotives were imported to this country from England. The following table has, therefore, been compiled from a Report made to the House of Representatives by the Secretary of the Treasury of the United States in 1838. In this report it is said:

"Of the whole number of locomotives in the United States propelled by steam, being about 350, the most which have been ascertained in any State is 96, in the State of Pennsylvania. Those in each State, respectively, can be seen in the table annexed (V 4).

"None of them were introduced here till A.D. 1831, though they now run on nearly 1,500 miles of railroad. The first one, it is believed, was in the State of Delaware, on the Newcastle Railroad; the second, in Maryland, on the Baltimore & Ohio Railroad; and the third, between New Orleans and Lake Pontchartrain, in the State of Louisiana. They had been tried in this country by Oliver Evans as early as 1804, and in England as early as 1805, but not reduced to useful practice in the latter till 1811 for freight, and in A.D 1830 for passengers and speed. One succeeded on a common road, from London to Bath, in 1829. Of the whole number of other steam machines in the United States (being about 1,860), the State of Pennsylvania has the most ascertained, being 383. The number in some States is not accurately ascertained; but near 300 more are ascertained and computed to exist in Louisiana alone. The introduction of them here, and especially with the high-pressure machinery, was much promoted by Oliver Evans about A.D. 1787, in the State of New Jersey, for raising water and earth from mines. The next was about 1791 in a cotton factory at Kensington, near Philadelphia; and soon after in saw-mills and iron slitting and rolling-mills at Pittsburgh."

This report shows how unreliable most history is. The Secretary of the Treasury of the United States is called upon by Congress to make a report, and with all the resources of his

department records that "it is believed" that the first locomotive was introduced here in 1831, in the State of Delaware, on the Newcastle Railroad, whereas there is undoubted testimony that the first locomotive was "introduced," although it was not successful, on the Delaware & Hudson Canal Company's line in 1829.

The following is a copy of Table V 4, referred to in the report of the Secretary:

LOCOMOTIVE STEAM ENGINES IN EACH STATE IN 1838.

LOCOMOTIVES AND RAILROAD ENGINES.

STATES.	Number.	Period when first introduced into use in the State.
Maine	2	1836
New Hampshire	None returned.	
Massachusetts	37	1832
Connecticut.*	....	
Rhode Island	6	1837
Vermont	None returned.	
New York	28	1832
New Jersey	32	1832
Pennsylvania	96	1832
Delaware	14	1831
Maryland†	31	1832
District of Columbia†	....	
Virginia	34	1834
North Carolina	5	1836
South Carolina	27	1832
Georgia	3	1837
Florida	2	1836
Alabama	1	1837
Louisiana	10	1832
Indiana, Missouri, and Illinois	None returned.	
Ohio	1	
Michigan	6	1838
Tennessee	None returned.	1836
Kentucky	2	
Wisconsin and Iowa	None returned.	
Aggregate returned	337	
Add as an estimate for those not returned	13	
Total	350	

It is not clear whether "railroad engines" included stationary engines used on railroads or not. Probably it did, so that the number of locomotives in use in this country in 1838 was less than 350.

Following Table V 4 is another which gives the number of "standing engines" in each State; 1,616 are reported and 244 "estimated," or a total of 1,860.

The stationary, steamboat, and "standing" engines in use in different parts of the country are reported separately. From these reports the following table has been compiled, and shows the number of locomotives in use in this country which had been imported from England. The table is probably not entirely complete, but includes 82 locomotives which were in use in this country at that time which were made in England. Wood's "Practical Treatise on Railroads"—third edition—gives a table of locomotives built by Robert Stephenson & Co., which includes a number sent to this country which are not included in our list. Among these is the celebrated *Brother Jonathan* for the Mohawk & Hudson Road. The list is interesting as showing what is not generally known at this time, that in the early days of railroading in this country a large proportion of the motive power was imported from England.

It is also interesting at this time to see the names of American builders of locomotives who were engaged in that business 56 years ago. The following list, made up from the report before us, will probably make some firms known to many of our readers of whose existence they never heard.

LOCOMOTIVE BUILDERS IN THE UNITED STATES IN 1838.

Proprietors Locks and Canal Company	Lowell, Mass.
M. W. Baldwin	Philadelphia.
Newcastle Manufacturing Company	Newcastle, Del.
William H. Norris	Philadelphia.
Seth Boyden	Newark, N. J.
H. B. Dunham & Co.	New York.
Rogers, Ketchum & Grosvenor	Paterson, N. J.
Gillingham	Baltimore, Md.
West Point Foundry Company	
Sellers & Sons	
Garrett & Eastwick	Philadelphia.
Rush & Muhlenberg	
Bolton & Co.	Boston.
McCluny, Wade & Co.	Pittsburgh.
Long & Norris	Philadelphia.
Thomas W. Smith & Co.	Alexandria, Va.
Watchman & Bratt	Baltimore.
Eason & Dotterer	Charleston, S. C.
McLeish & Smith	" "
J. Ross	" "
E. K. Dod	New York.

* The locomotives on the Stonington and Providence Railroad are returned to the State of Rhode Island.

† Those on the Baltimore and Washington Branch Railroad are included under the Maryland returns.

THE SCIENTIFIC USES OF LIQUID AIR.

ONE of the largest and most distinguished audiences ever assembled at the Royal Institution crowded the theatre recently to hear Professor Dewar's lecture on the scientific uses of liquid air. They were rewarded with a lecture containing matter that would furnish forth half a dozen ordinary discourses, and opening up questions which years of labor may prove inadequate to answer.

To the majority of people liquid air is only a scientific marvel, to a few it presents a collection of unsolved and most interesting problems, while at the Royal Institution it has become a valuable instrument of physical research. Produced in large quantities and stored by novel and ingenious methods, it is employed in the study of matter at 200° below zero, exactly as a spirit lamp or a gas flame is used in studying the properties of different bodies at temperatures equally removed in the opposite direction from the normal. Professor Dewar's lecture dealt in part with some properties of the liquid itself, which have not previously been studied in equally favorable conditions, but was more particularly concerned with indicating the various important applications of a new and potent instrument of physical investigation.

Liquid air was shown in a condition which, though probably offering nothing novel to the eye of the untrained observer, is yet essentially different from anything hitherto shown on a lecture table. It has always been seen either in a state of active ebullition at ordinary pressure, or of steady evaporation at the lower temperature produced by the action of an air-pump. A few nights ago it was shown as a permanent fluid giving off no gas. Or, to put the matter another way, it has hitherto been shown imperfectly screened from the heat of surrounding bodies, while now it has been placed in such conditions that no extraneous heat could reach it. Formerly its temperature was kept down by its own evaporation, exactly as the temperature of boiling water is kept constant over the hottest fire. As exhibited by the lecturer, its temperature was kept constant without loss of mass. This is effected by placing the liquid in a vacuum jacket, which is immersed in liquid oxygen contained in a second vacuum jacket and connected to an air pump. Convection is annihilated by a vacuum which must be all but absolute, and conduction is shut out by the surrounding oxygen. No access of heat is possible except by radiation pure and simple, and this has already been proved to be, if not non-existent, at all events infinitesimally small. It is an interesting incident of the arrangement that common air can be shown in the solid condition. The importance of the complete isolation of the liquid lies in the fact that exact experiments can be made for the determination of its specific and latent heat. By lowering into the liquid a definite mass of platinum and measuring the gas evolved, it is easy to calculate the heat that becomes latent in converting the liquid into gas. Using similar methods to heat the liquid to a definite extent without altering its condition—*i.e.*, without converting it into gas—the specific heat can be calculated from the variation of pressure as registered by a column of mercury.

Taking a very highly exhausted bulb, containing only a little vapor of mercury at a pressure of one-millionth of an atmosphere, and cooling it with liquid air until that minute portion of metal was frozen solid, the lecturer illustrated the part played in electrical discharges by ponderable matter. In a high vacuum at 200° below zero the difficulty of passing an electric spark in any form becomes almost insuperable. It would not be an extravagant inference from the phenomena were we to affirm that at 274° below zero, when the rarest gas known to us would have suffered condensation, electrical discharge through the frozen void would become altogether impossible. But there are constant warnings in physical science of the danger of pushing inference beyond experiment, at all events in regions where we are approaching the extreme limit of our resources. By enormously increasing its voltage the current may be made to pass even through the frozen-out mercury vacuum; but the discharge assumes a totally different

LOCOMOTIVES USED ON RAILROADS IN 1838 WHICH WERE IMPORTED FROM ENGLAND.

Name of Railroad.	Name of Locomotive.	When Constructed.	By Whom Constructed.	How Long in Use.
		Year.		
Bangor & Piscataqua	Pioneer	1836	Robert Stephenson, Newcastle	Since November 25, 1836.
“ “	No. 6	1836	“ “ “	“ “ “
Boston & Providence	Whistler	1833	A. L. Stevenson, “	5 years.
“ “	Boston	1835	Edward Bury, Liverpool	3 “
“ “	New York	1835	George Forester, Liverpool	3 “
Boston & Worcester	Lion	1836	Edward Bury, “	2 “
“ “	Meteor	1834	Robert Stephenson, Manchester (?)	4 “
“ “	Comet	1835	“ “ “	3 “
“ “	Rocket	1835	“ “ “	3 “
“ “	Mercury	1835	“ “ “	3 “
“ “	Jupiter	1835	“ “ “	3 “
Boston & Lowell	Stephenson	1832	“ “ Newcastle	6 “
Saratoga & Schenectady	Fire Fly	1832	Robert Stephenson & Co., England	Since 1833.
“ “	Davy Crockett	1833	“ “ “ “	“ “
Camden & Woodbury	Fire Fly	1833	C. Tayleur & Co., Liverpool	5 years.
“ “	Red Rover	1833	“ “ “	5 “
Camden & Amboy	No. 1	1832	Swartwout, Liverpool	6 “
Paterson & Hudson River	McNeil	1833	In England	4 “
Philadelphia & Reading	Rocket	1837	Braithwait, London	2 months.
“ “	Fire Fly	1837	“ “	2 “
“ “	Spit Fire	1837	“ “	1 month.
“ “	Dragon	1837	“ “	1 “
Philadelphia & Wilmington	Wilmington	1836	Edward Bury	21 months.
Philadelphia & Columbia	Kentucky	1835	Stephenson	3½ years.
“ “	John Bull	1835	“	3½ “
“ “	Atlantic	1835	“	3½ “
Newcastle & Frenchtown	Delaware	1831	Robert Stephenson, Newcastle	Since August, 1832.
“ “	Pennsylvania	1832	“ “ “	“ November, 1832.
“ “	Virginia	1833	“ “ “	“ August, 1833.
“ “	Phœnix	1832	“ “ “	“ February, 1833.
Allegheny Portage	Delaware	1833	E. A. Young, Newcastle	4 years.
“ “	Allegheny	1834	“ “ “	3 “
“ “	Comet	1837	“ “ “	1 year.
Baltimore & Susquehanna	Herald	1832	Robert Stephenson & Co., England	6 years.
“ “	No. 151	1837	“ “ “ “	Not in use.
“ “	No. 152	1837	“ “ “ “	“ “ “
Richmond, Fredericksburg & Potomac	Roanoke	1832	Edward Bury, Liverpool	6 years.
“ “ “	Richmond	1834	Robert Stephenson, Liverpool (?)	3 “
“ “ “	Augusta	1835	Edward Bury, Liverpool	2½ years.
“ “ “	Fredericksburg	1835	“ “ “	2½ “
“ “ “	Potomac	1836	Benjamin Hick, Bolton	2 “
“ “ “	Louisa	1837	“ “ “	1½ “
“ “ “	Jefferson	1837	Summer, Graves & Day, Southampton	½ year.
“ “ “	John Randolph	1837	Edward Bury, Liverpool	½ “
“ “ “	Sheppard	1837	“ “ “	½ “
“ “ “	Stafford	1837	“ “ “	½ “
“ “ “	Patrick Henry	1837	“ “ “	½ “
“ “ “	Robert Morris	1837	Rothwell, Newcastle	¼ “
“ “ “	Oliver Evans	1837	“ “	¼ “
Petersburg	Liverpool	1833	Edward Bury, Liverpool	Since 1833.
Greensville & Roanoke	Nottoway	1833	Rothwell & Hick, Bolton	“ “
Raleigh & Gaston	Meherrin	1833	Edward Bury, Liverpool	“ “
“ “	Appomattox	1833	“ “ “	“ “
“ “	Staunton	1834	“ “ “	“ 1834.
“ “	Petersburg	1834	“ “ “	“ “
“ “	Gaston	1836	C. Tayleur & Co., Warrington	“ 1836.
“ “	Raleigh	1836	“ “ “	“ “
“ “	Roanoke	1837	Edward Bury, Liverpool	“ 1837.
“ “	Virginia	1837	Benjamin Hick, Bolton	“ “
Wilmington & Raleigh	Wayne	1837	Robert Stephenson	14 months.
“ “	Nash	1837	“ “	14 “
“ “	Halifax	1838	D. & I. Burr & Co.*	3 “
“ “	Sampson	1838	“ “ “	1 month.
South Carolina	Georgia	1834	Edward Bury, Liverpool	Half the time.
“ “	Augusta	1834	“ “ “	“ “ “
“ “	William Aiken	1834	Stephenson & Co., Liverpool	One-fourth the time.
“ “	E. Houy	1834	“ “ “	One-fifth “ “
“ “	H. Schultz	1835	Rothwell, Bolton	“ “ “
“ “	Sumter	1835	Stephenson & Co., Liverpool	One-third “ “
“ “	Marion	1835	“ “ “	“ “ “
“ “	Ohio	1835	“ “ “	“ “ “
“ “	Cincinnati	1835	Tayleur, Liverpool	One-fifth “ “
“ “	Allen	1835	“ “	One-fourth “ “
“ “	Kentucky	1835	“ “	One-fifth “ “
“ “	Tennessee	1836	Rothwell, England	One-sixth “ “
Ponchartrain	Ponchartrain	1832	Rothwell, Hick & Rothwell	5 years.
“	Oreole	1833	Edward Bury	4 “
“	Fulton	1834	Benjamin Hick & Son	3 “
“	Orleans	1836	Edward Bury	2 “
Carrollton	New Orleans	1837	Benjamin Hick & Co	3 months.
Lexington & Ohio	Nottoway	1836	John Bull (?)	2 years.
“ “	Elkhorn	1836	“ “	2 “

* It is not certain whether these were English or American builders.

form, the diffused phosphorescence giving place to luminous streaks. It would seem, therefore, that after a certain degree of rarefaction has been attained the gaseous molecules are no longer sufficient in number to act as carriers for an ordinary charge, while a more powerful one bridges the space only by the aid of the few that remain. The result almost justifies the presumption that ponderable matter is always necessary for the passage of electricity through space, but at the same time it opens up the question whether space can ever be wholly free of ponderable matter. If a certain amount of vapor be still given off by mercury at 140° below its freezing-point, to what temperature below *minus* 274° must we suppose hydrogen to be cooled in order to insure that no residuum shall remain in the gaseous form ?

Professor Dewar carried out a very simple but very striking experiment which forcibly demonstrates the truth of the molecular theory. He took a high vacuum bulb containing only a minute quantity of mercurial vapor, to which was connected by a short neck of from one-tenth to one-eighth of an inch bore a smaller bulb containing liquid mercury. On applying liquid air to a portion of the larger bulb the contained vapor was at once condensed as a small mirror. On applying the liquid to a second portion of the glass no further condensation was obtained, thus proving that the metallic surface a couple of inches below could not supply vapor to replenish the larger bulb. But on inclining the apparatus so as to pass a globule of mercury into the larger bulb itself the cold spots on the glass were instantaneously covered with dense metallic depos-

its. Of the myriads of molecules projected in all directions from the liquid mercury in the smaller bulb only a small percentage—which might be determined by the theory of probabilities—struck the orifice of the neck in such a way as to shoot clean through into the larger bulb. Hence the loss from condensation could not be made good, although there was free communication with another chamber containing vapor at a relatively high pressure.

The lecturer showed the method of determining the tensile strength of metals at 180° below zero. Large quantities of liquid air are necessary, since the considerable mass of metal forming the jaws of the testing machine has to be completely immersed. The results are extremely interesting. The breaking strain is in all cases greatly increased, and in some—*e.g.*, iron and German silver—is nearly doubled. In the case of certain metals equally remarkable increase occurs in the percentage of elongation before rupture, though the results on this point require verification. Thus, while chemical forces are in abeyance at very low temperatures, the physical force, which we call cohesion, asserts itself with immensely increased power. This is of great importance in connection with theories which have been ably advocated in some quarters, according to which a sufficient reduction of temperature would reduce the universe to "cosmic dust." That material, so valuable to some speculators, will have in future to be obtained from some other source than the disintegration of matter by cold. Lord Kelvin maintains, on the other hand, that cohesion may be accounted for without assuming any other force than that of gravitation, or any other law than the Newtonian. Contraction of bulk without reduction of mass is the sole condition he requires for indefinite increase of cohesive force, and this is obviously the condition supplied by Professor Dewar's experiment, while the result is entirely concordant with Lord Kelvin's theory.

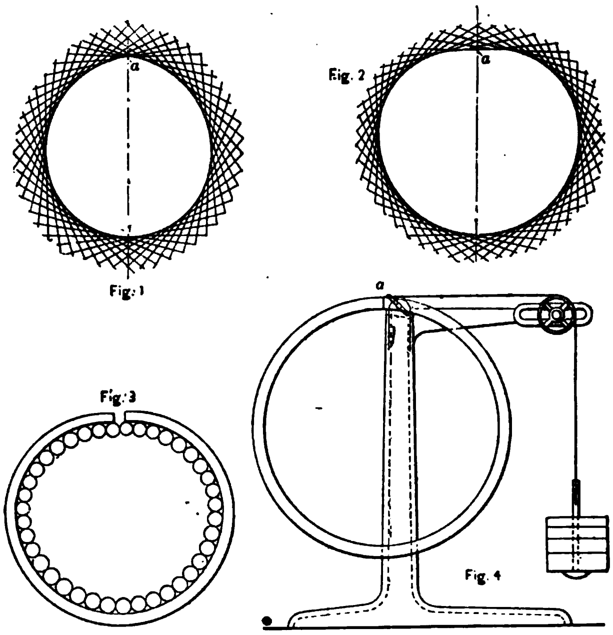
An American experimenter has found that a temperature of 80° below zero very greatly diminishes the power of a permanent magnet. But Professor Dewar has proved that this result follows only in the case of a super-saturated magnet. If a magnet be taken which has been passed through ordinary cycles of change, and therefore carries what may be called a normal charge of magnetism, its magnetic activity is markedly increased by reduction of temperature. This was shown by direct experiment, and the result was confirmed by coiling a wire round the magnet at ordinary temperature and immersing the end of the magnet in liquid air, when an electric current was instantly generated in the wire. An immense field of work lies before the physicist in connection with these experiments alike upon cohesion and upon magnetism. There are various theories which will have to take account as best they can of facts which cannot be questioned, however they may ultimately be explained. The increase of cohesion and magnetic force at very low temperatures must be taken in conjunction with the disappearance of electrical resistance in pure metals already worked out at the Royal Institution, and this, again, is complicated by the reverse effect obtained when the metals are contaminated by impurities of any kind.

Low temperature was shown to have a remarkable effect upon the color of many bodies. For example, the brilliant scarlet of vermilion and mercuric iodide is reduced under the influence of intense cold to a pale orange, the original color returning with the rise of the temperature. Blues, on the other hand, are unaffected by cold, and the effect is comparatively small upon organic coloring matters of all tints. This is of interest in connection with the efforts that have been made to find a chemical explanation of the color of salts, and, indeed, with the phenomena of isomorphism in general.

It may be judged from this imperfect sketch how numerous and far-reaching are the possibilities of the work now being done at the Royal Institution.—*London Times.*

DUNBAR'S PISTON-PACKING RINGS.

A NEW packing ring for pistons, and the scheme that was followed in its development, are illustrated herewith. It is a plain ring made in such shape that it will fit a cylinder and make the piston steam-tight with the least possible frictional resistance. Fig. 1 was made from a 16-in. ring after it had ¾ in. cut out, then springing it together, and holding it by a flexible band. It was then laid on drawing paper, and a line was drawn on its inner circumference. It was then removed, the line spaced off into inch spaces, and from the space points the lines were drawn that bound the figure, which shows the shape that a round ring will take, when about $\frac{3}{16}$ in. to the foot is cut out of it and then sprung together by an equal external radial pressure. Fig. 2 was made from a like ring cut in two with a very thin tool, sprung apart ¾ in. less the thickness of the tool, and held open by a number of short rounds, as shown in fig. 3. The line was then drawn on the outside of the ring, spaced, and the figure outlined, as in fig. 1. The rounds produce an equal internal radial pressure the opposite of fig. 1. Hence it follows that if a 16-in. ring is made the shape of fig. 2, then ¾ in. cut out and sprung together by an equal external radial pressure, the ring will be round. The cut in the rings is at *a*. The rings are cast close to size and



NEW METHOD OF FORMING PISTON RINGS.

shape, then ground to the exact size. Fig. 4 is a tester by which the tension and circularity of a ring may be determined. The ring is clamped in the vise at the top of the column, near one of its ends, a steel tape is secured to the end in the vise, the tape is passed around the ring and over the friction pulley on the arm, and weights applied to the end till the cut is closed, when its circularity may be tested.

PRICES OF NOVA SCOTIA COAL.

THE following report has been made by our Consul-General at Halifax, to the Bureau of Statistics, Department of State, at Washington, which will be interesting in view of the agitation growing out of the discussion of the Wilson bill.

In compliance with the request of the Department, I enclose a statement covering the cost of mining coal in Nova Scotia and of shipping it to the United States, prepared by Mr. M. R. Morrow, of Halifax, who is considered the highest authority:

Cape Breton coal,* at mines' ports, which are all within 25 miles of the respective mines—

	Per ton.
Screened	$2 50
Run of mine	1 80
Slack	1 10

These are subject to a discount of 5 cents per ton for 1,000 tons and over, 10 cents per ton for 5,000 tons and over, and 15 cents per ton for 10,000 tons and over.

Pictou coal, shipped at Pictou, about 15 miles from the mines—

	Per ton.
Screened Acadia	$2 50
Run-of-mine Acadia	2 25
Slack Acadia	1 50
Culm	80
Screened Drummond	2 25
Run-of-mine Drummond	2 00
Slack Drummond	1 50
Culm Drummond	80

* It is assumed that this is the price at mines' ports, although the report does not distinctly say so.

Pictou is closed to navigation for five months of the year, when the coal must be shipped from Halifax, 100 miles distant, at an additional cost over Pictou of 80 cents per ton.

Spring Hill coal, at Parrsborough, 27 miles distant from the mines—

	Per ton.
Screened	$2 75
Run of mine	2 50
Slack	1 40
Culm	1 00

The estimated cost in 1893 of mining and shipping the various coals of the province, free on board vessels at the mines' ports, for run-of-mine coal was :

	Per ton.
Cape Breton coal	$1 40
Pictou coal :	
Acadia mine	2 00
Drummond mine	1 85
Spring Hill coal	2 15

Prices paid miners at Cape Breton mines were as follows :

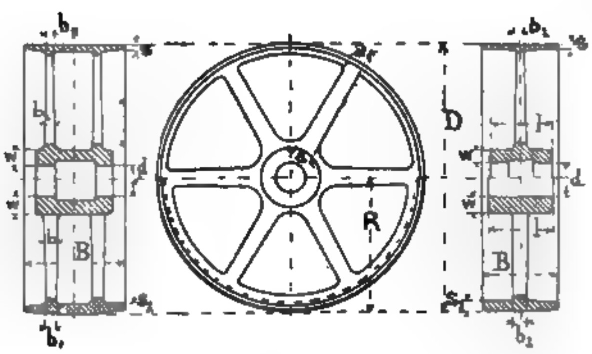
	Per ton.
Gowrie	$0 46
Little Glace Bay	42
International	44
Old Bridgeport	44
Reserve	42
Emery	43
Gardener	55

Coal freights from Nova Scotia to New England during the last five years averaged $1.90 per ton on the small quantity sent there, which was mostly in sailing-vessels.

The above prices and rates are for the ton of 2,240 lbs.

DARIUS H. INGRAHAM,
Consul-General.

HALIFAX, January 4, 1894.



DIMENSIONS OF CAST-IRON PULLEYS.

DIMENSIONS OF CAST-IRON PULLEYS (SINGLE ARMS).

BREADTH FROM 4 IN. TO 6½ IN.

D	No. of Arms.	a	a_1	b	b_1	e	e_1
in. in.							
6 to 12	4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12¼ " 15¾	4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16¼ " 19¾	4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20 " 23¾	4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] full	[illegible]
24 " 27½	4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] full	[illegible] full
24 " 27½	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] full	[illegible]
28 " 31½	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] full	[illegible] full
32 " 35½	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] full	[illegible] full
36 " 39½	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] full	[illegible] full
40 " 42½	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
43½ " 47½	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
47½ " 51	6	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]
51½ " 55	6	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
55½ " 60	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

$W = \frac{d}{6} + \frac{D}{100} + \frac{1}{8}$ in. $l = d$ to $2.5d$. $r = 0.75a$ = radius of elliptical arm.

DIMENSIONS OF CAST-IRON PULLEYS (SINGLE ARMS).

BREADTH FROM 6½ IN. TO 11 IN.

D	No. of Arms.	a	a_1	b	b_1	e	e_1
in. in.							
8 to 12	4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12¼ " 15¾	4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16¼ " 19¾	4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20 " 23¾	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
24 " 27½	6	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]
28 " 31½	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] full
32 " 35½	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] full
36 " 39½	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
40 " 42½	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
43½ " 47½	6	[illegible]	[illegible]	1¼ full	[illegible]	[illegible]	[illegible]
47½ " 51	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
51½ " 55	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
55½ " 61	6	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]
61½ " 67	6	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]
67½ " 72½	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
67½ " 72½	8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
72½ " 78½	6	3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
72½ " 78½	8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

$W = \frac{d}{6} + \frac{D}{100} + \frac{1}{16}$ in. $l = 1.5d$ to $3.5d$. $r = 0.75a$ = radius of elliptical arm.

—*Mechanical World.*

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

THE object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publication will in time indicate some of the causes of accidents of this kind, and help to lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with information which will help to make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we all intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in January, has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS FOR JANUARY.

Pottsville, Pa., January 1.—A collision occurred on the Mahanoy Division of the Lehigh Valley Railroad, between Buck Mountain and Delano, this afternoon. A coal train pulling out from a siding from a colliery collided with a passenger train. Both engineers were badly hurt.

Little Rock, Ark., January 1.—A boiler of a freight train exploded near Beebe, on the Iron Mountain Road, this morning. John Dooley, the fireman, was severely injured. The engineer escaped with slight injuries.

East Weymouth, Mass., January 5.—An engine collided with a Middleborough train at this point to-day and was thrown from the track. The engineer, Mildram, was slightly injured, and Frank Williams, fireman of the wrecked train, was cut.

Parkville, N. Y., January 9.—Two work trains used in making repairs on the Long Island Railroad collided at this point this morning. Fireman Waren sustained a compound fracture of the leg.

Franklin Falls, N. H., January 11.—A boiler of a locomotive exploded at this point to-day, injuring the engineer, Ed. Bowler, very severely by breaking one leg and badly bruising his head. John Ballantyne, the fireman, was badly scalded.

Meadville, Pa., January 11.—A wreck on the Pittsburgh, Shenango & Lake Erie Railroad occurred to-day. Fireman Porter was very severely injured, and it is feared he might die from his injuries. Engineer Unger was seriously hurt, and at the time of this dispatch the chances are against his recovery.

Easton, Pa., January 13.—A fast freight on the Lehigh Valley Railroad ran into the rear of a preceding section on a high embankment where the road enters the town of Phillipsburg, N. J. The engineer and fireman remained on the engine until it stopped. Engineer Hanlan had his arm broken.

Pittsfield, Me., January 13.—An engine on the Canadian Pacific Railroad jumped the rails near Jackman to-day, careen-

LOCOMOTIVE RETURNS FOR THE MONTH OF NOVEMBER, 1893.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage.					Av. Train.		Coal Burned per Mile.						Cost per Locomotive Mile.							Cost per Car Mile.		Cost of Coal per Ton.
			Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Passenger Cars.	Freight Cars.	Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Passenger.	Freight.	
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Atchison, Topeka & Santa Fé	822	744	....	....	....	2,285,110	3,004	....	....	....	....	....	90.54	....	...	4.53	7.72	0.22	0.14	6.81	1.25	20.67	....	....	1.64
Canadian Pacific	613	582	475,790	759,420	415,080	1,650.290	2,88[illegible]	....	....	....	....	....	78.29	....	...	3.99	11.72	0.35	....	5.78	1.39	23.23	....	....	3.20
Chic., Burlington & Quincy	542	....	....	....	....	1,485,812	2,741	5.34	19.24	....	....	....	90.17	....	.	3.80	6.49	0.22	0.27	6.61	0.06	17.45	....	....	1.48
Chic., Milwaukee & St. Paul	856	...	....	....	....	2,700,677	3,155	....	...	....	....	....	79.27	....	....	3.83	8.02	0.27	...	6.78	....	18.90	....	....	2.88
Chic., Rock Island & Pacific	...	....	508,205	1,018,431	341,535	1,858,171	....	....	..	....	....	....	....	....	....	....	....	....	....	....	....	....	..	....	....
Chicago & Northwestern	1010	....	814,064	1,449,375	645,274	2,908,718	2,879	....	...	....	...	....	94.56	....	....	3.58	8.54	0.30	....	6.37	0.76	19.55	....	....	1.79
Cincinnati Southern	....	....	....	....	....	....	....	....	....	...	....	....	....	....	...	....	....	....	...	....	....	....	....	....	....
Cumberland & Penn.*	23	23	5,186	37,747	....	42,933	1,866	....	....	....	....	....	90.74	....	...	8.14	4.58	0.30	....	...	1.68	14.66	....	....	....
Delaware, Lackawanna & W. Main L.	211	194	....	....	....	677,100	3,490	....	....	..	....	....	99.15	....	....	2.69	7.50	0.39	....	6.01	....	16.59	....	...	...
Morris & Essex Division	163*	....	178,040	153,087	95,755	426,882	2,618	....	....	...	....	....	68.56	....	....	3.65	10.69	0.35	....	6.48	....	21.17	....	....	3.08
Hannibal & St. Joseph	69	69	....	....	....	240,027	3,582	5.13	17.60	....	....	....	87.22	13.71	6.43	2.31	6.86	0.18	0.40	6.99	0.02	16.71	....	....	1.18
Kansas City, F. S. & Memphis	148	....	92,432	220,058	98,693	411,178	2,816	....	....	....	....	....	71.81	....	....	3.08	6.08	0.23	0.40	7.33	...	17.07	....	....	1.65
Kan. City, Mem. & Birm	42	40	34,970	62,675	15,134	112,679	2,817	....	....	...	....	...	69.01	....	....	2.98	3.94	0.25	0.33	6.87	....	14.32	....	....	1.10
Kan. City, St. Jo. & Council Bluffs	37	37	50,108	41,515	37,138	128,761	3,480	5.71	22.00	....	....	..	73.77	14.63	4.98	2.87	8.27	0.16	0.46	6.28	0.04	18.08	....	....	2.34
Lake Shore & Mich. Southern	594	....	428,499	809,463	443,458	1,681,420	3,057	....	....	68.79	96.61	22.12	74.54	....	....	2.27	5.78	0.07	0.11	6.90	0.18	15.81	....	....	1.54
Louisville & Nashville	....	....	....	....	....	....	...	..	...	....	...	....	...	....	....	...	....	....	....	....	....	....	....	....	....
Manhattan Elevated	291	....	743,978	....	65,426	809,404	2,781	....	....	...	....	...	43.19	....	....	2.60	8.50	0.20	....	9.20	...	20.50	....	....	3.92
Mexican Central	148	122	....	....	....	394,374	3,232	..	...	....	....	...	71.55	....	....	5.51	14.03	0.48	0.21	4.69	0.68	25.55	....	....	4.34
Minn., St. Paul & Sault Ste. Marie	103	90	83,413	128,825	54,618	266,856	2,965	4.94	21.45	...	....	....	76.10	....	5.17	4.52	13.78	0.26	....	6.65	....	25.21	4.19	1.82	3.61
Missouri Pacific	346	....	....	....	....	1,018,282	3,375	4.41	17.58	....	....	...	90.09	....	....	5.00	6.34	0.34	1.20	6.37	1.44	20.69	4.06	1.48	1.89
Mobile & Ohio	107	85	74,166	166,477	58,328	298,971	3,517	...	....	....	....	....	68.08	....	....	2.64	4.88	0.22	0.59	5.32	0.85	14.50	....	....	1.48
N. O. and Northeastern	....	....	....	....	....	....	....	....	....	....	....	....	..	....	...	....	...	....	....	....	....	....	....	....	...
N. Y., Lake Erie & Western	638	410	440,475	871,459	260,385	1,572,319	3,885	4.70	23.90	92.50	145.20	94.50	110.78	19.60	6.10	4.78	8.14	0.37	2.01	7.48	1.15	23.88	....	....	1.87
N. Y., N. H. & H., Old Colony Div	....	....	401,240	143,825	184,530	729,595	....	4.00	16.40	...	....	....	63.66	16.50	5.50	3.38	9.54	0.62	...	7.06	0.87	21.42	....	..	....
N. Y., Pennsylvania & Ohio	273	181	135,595	421,762	128,633	685,990	3,518	5.60	17.50	111.70	182.20	77.75	108.22	20.40	7.50	4.68	6.78	0.31	1.70	6.91	1.00	21.33	....	....	1.12
Norfolk & Western, Gen. East. Div.†	....	....	90,360	291,602	44,278	436,240	2,644	5.50	20.70	54.08	129.74	....	91.91	9.90	6.80	5.50	4.11	0.28	....	....	....	9.89	....	....	3.60
General Western Division†	....	...	97,040	305,996	51,084	454,070	2,793	5.68	16.02	89.60	133.00	....	111.00	15.80	8.28	6.07	4.61	0.26	....	...	....	10.94	....	....	....
Ohio and Mississippi	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	...	....	....	....	....	....	....	....	...	....
Philadelphia & Reading	....	....	420,908	306,623	....	1,708,228	....	....	....	....	....	....	80.45	....	..	4.09	4.92	0.34	...	5.85	0.42	15.62	....	....	....
Southern Pacific, Pacific System	737	665	618,662	850,268	264,341	1,733,271	2,352	5.50	14.27	....	....	....	69.35	....	....	4.49	16.93	0.20	2.23	7.33	1.14	32.32	...	...	....
Union Pacific	989	989	527,047	1,422,488	408,578	2,358,113	3,483	6.49	17.74	...	....	....	110.25	....	....	6.82	10.57	0.39	....	8.04	1.08	26.90	3.89	1.90	1.91
Wabash	425	355	426,166	614,491	228,946	1,269,603	3,574	4.86	17.14	71.53	111.22	60.59	90.09	14.70	6.48	3.58	5.18	0.28	....	6.19	0.90	16.18	2.94	1.08	1.19
Wisconsin Central	149	106	114,399	163,978	46,132	324,509	3,061	....	....	....	....	...	84.21	....	....	3.31	9.63	0.20	...	7.19	....	20.33	....	....	2.27

Note.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars. Empty cars which are reckoned as one loaded car are not given upon all of the official reports, from which the above table is compiled. The Union and Southern Pacific, and New York, New Haven & Hartford rate two empties as one loaded; the Kansas City, St. Joseph & Council Bluffs and Hannibal & St. Joseph Railroads rate three empties as two loaded; and the Missouri Pacific and the Wabash Railroads rate five empties as three loaded, so the average may be taken as practically two empties to one loaded.

* Switching engines allowed 6 miles per hour; wood, construction and gravel trains, 10 miles per hour.

† Wages of engineers and firemen not included in cost.

ing and tipping over. Engineer William Hunting had both legs so badly broken that it is thought he cannot recover.

Pittsfield, Me., January 13.—A mogul engine with a snow-plow ahead, on the Canadian Pacific Railroad, while engaged in clearing the track encountered a deep drift near Harvey Lake, in which the engine jumped the track and went out upon the ice upon the lake. The engineer escaped through the cab window, but as the locomotive went down the fireman was pinned in and was drowned in 28 ft. of water.

Statesville, N. C., January 13.—An engine of a passenger train on the Murphy Division Branch of the Western North Carolina Road jumped the track near Nantahala to-night, rolled down an embankment, and the engineer was severely scalded.

Winchester, Ind., January 13.—An engine pulling a freight train exploded its boiler on the Big Four track in front of this station to-day, while the train was running at the rate of about 10 miles an hour. Both ends of the boiler and the bottom were blown out. Albert Rankin, the fireman on the engine, was scalded to death. Lafe Mullen, the engineer, escaped with slight injuries.

Halifax, N. S., January 14.—A snow-plow and engine on the Windsor & Annapolis Railway broke through a bridge between Middletown & Wilmot to-day. Engineer Pudsey and Fireman Frank Smith were instantly killed.

Harrison, N. J., January 15.—While the Dover Express on the Delaware, Lackawanna & Western Railroad was approaching the draw-bridge over the Hackensack River this morning, it ran into a preceding train at a speed of 20 miles an hour, crushing into the rear and telescoping four cars. David Hoffman, the engineer, was seriously injured and carried into the baggage car in an unconscious condition. His legs and head were cut and bruised, and he is supposed to be internally injured. The fireman was slightly injured.

Santa Rosa, Cal., January 15.—An accident occurred on the narrow-gauge road at the Austin River bridge to-day. A locomotive was detached from the train to reconnoiter for washouts. It crossed the bridge in safety, but in returning, the piling having been undermined, the engine crashed through. Engineer Briggs and Fireman Colliston were drowned.

Montreal, Can., January 15.—Edgar Vary, a fireman on the Grand Trunk train, was underneath his engine to day, when another train came up with the object of coupling some cars. The contact was made too suddenly, and Vary was injured about the hips.

Syracuse, N. Y., January 16.—George Gilwater, a fireman on the New York Central & Hudson River Railroad, was struck on the head by a mail crane while leaning out of the cab this morning. He was rendered unconscious, but suffered no serious injury.

South Shaftesbury, Vt., January 16.—A passenger train on the Bennington & Rutland Road collided with a wrecking train about a mile from this station this morning. Engineer William Smith died from injuries which he received.

Weston, W. Va., January 19.—A wreck occurred in the mountains of Randolph County to day. McQuay's log engine with a train loaded with logs ran away down the mountain, badly injuring E. M. Shives, engineer.

St. Louis, Mo., January 20.—A Wabash engine jumped the track and ran into the Mississippi River at East St. Louis to-day. George Kirby, the engineer, was drowned.

Montgomery, Ala., January 21.—A train on the Central Railway of Georgia ran into a cow near Fitzpatrick to-night and was thrown from the track. Engineer Williams and Fireman Kimball were badly scalded.

Fort Worth, Tex., January 22.—Engineer Bethel, of the Rock Island Road, while engaged in oiling his engine at Chicasha this evening, was struck on the head and severely injured.

Cedar Rapids, Ia., January 23.—A Burlington, Cedar Rapids & Northern train was wrecked near Potsville this evening by a broken rail. The engine and four cars were overturned. Engineer Tencill Sheffrenik was caught under the tank and killed.

Springfield, Ill., January 28.—A wreck occurred on the St. Louis, Chicago & St. Paul Railroad about 3 miles south of Curren this evening, which resulted in the death of Engineer William Deadman, of Alton.

Como, O., January 29.—A rotary snow-plow pushed by two engines on the Union Pacific Line ran into a broken rail near this point to-day, and the plow and one of the engines ran off the embankment, rolling over three times and landing 150 ft. from the track. Engineer Snow and Fireman Calihar received severe injuries.

Columbia, Pa., January 29.—A broken axle on an east-bound freight train on the Philadelphia Division, Pennsylvania Railroad, was the cause of a bad crash near Docklow to-day. Fireman John Rupert was injured by being caught between falling timbers as he jumped from the engine.

Millerton, Pa., January 30.—A train on the Tioga Railroad was stuck in a snow drift 5 ft. deep here this evening. The snow packed so hard against the cab on the fireman's side that it was forced in. George Case, the fireman, was dragged from the cab, but not until he had been suffocated to death in the snow.

Rochester, N. Y., January 30.—An east-bound passenger train on the New York Central & Hudson River Railroad, while taking a side track at Albion this evening, ran into an open switch. Engineer Osborn E. Chamberlain tried to jump, but his left leg was caught between the engine and tender. When released an hour later it was found that both bones were broken at the knee and ankle; he also complained of other injuries. Fireman Brooker was thrown through the cab window, striking his head on a pile of stones. A deep gash was cut across the forehead, and his nose was broken and right leg injured.

St. Paul, Minn., January 31.—An engine pulling a passenger train on the St. Paul & Duluth Railroad broke a side-rod about 2 miles west of Barnum this afternoon. It damaged the cab and broke a small cock on the boiler, allowing the steam and water to escape. Hank Gage, the engineer, was scalded, also his fireman.

Our report for January, it will be seen, includes 27 accidents, in which five engineers and five firemen were killed, and 16 engineers and 13 firemen were injured. The causes of the accidents may be classified as follows:

Boiler explosions	4
Broken axle	1
Broken rails	2
Broken side-rod	1
Cattle on track	1
Collisions	5
Defective bridges	2
Derailments	3
Misplaced switch	1
Runaway engine	1
Run over	1
Suffocated by snow	1
Struck by obstruction	1
Unknown	3
	27

PERFORMANCE OF A COMPOUND LOCOMOTIVE ON THE LONG ISLAND RAILROAD.

The following statement gives particulars of the performance and economy of compound locomotive No. 145, in comparison with single-expansion locomotive No. 138, built by the Baldwin Locomotive Works for the Long Island Railroad Company.

The engines set apart for the test by Mr. Prince, Superintendent of Motive Power, were compound engine No. 145 and simple engine No. 138. These engines were built by Burnham, Williams & Co., 1893, and are precisely similar, except for the compounding of No. 145 on the Vauclain four-cylinder type. They had both been in the shops for general repairs at a late date, and were put on this service as being both in equally good running condition.

For the purpose of this test:

1. A train of 20 loaded cars was set apart for the haul.
2. The section of track between Hempstead Crossing and Ronkonkoma was used; and the train hauled the round trip twice each day, making a total daily run of 118.78 miles.
3. Two cars of Clearfield coal were set apart by the storekeeper as being from the same mine, and were used exclusively on the series of tests.
4. It was decided to run the test train three days with one engine, and then three days with the other, making a series of tests of three days with each.
5. All coal was weighed on and off, from point of start to return to that point, and the water consumption was measured with Thompson patent water meters attached to the injector or suction pipes.

It will be seen that with the same train over the same course the work on each day was the same. On the first three days the compound engine was used; on the second three days the simple engine. On the first day's run with each engine the flue tubes and grates and front end were all perfectly clean, and on all succeeding days all conditions were similar, and the engines were in simple running order. Each day's run for consumption was reckoned only from the time of starting with

the train, and each day was concluded exactly at the point of origin, the fires being brought up to level as at starting, and the water in boiler being brought exactly up to the level of top cock, the same engineer and fireman being retained for the whole series.

All weather conditions were adverse to the compound engine; as one day (November 4) was exceedingly wet, and on the succeeding day the coal was still soaking from the previous one. The resultant economy, it will be seen, is figured up as 37.2 per cent. in coal and 17.2 per cent. in water on the simple basis of *per car per mile;* but making allowance for the increased length of terminal stoppages with the simple engine, I have also entered up the economy per car per mile *per hour* as 32.1 per cent. in coal and 10.7 per cent. in water, each in favor of the compound engine.

the crown of the arch, and about 38 ft. wide. The total cost of the work will be $1,700,000.

Conversion of a Steam into an Electric Road.—The Brooklyn, Bath & West End Railroad, which runs from Greenwood Cemetery to Coney Island, and which was originally built as a dummy road, and operated for the last few years as a steam road doing a heavy traffic, especially in the summer time, between Coney Island and Bath Beach and Brooklyn, has been changed into an electric road. This is the first instance in New York State in which the substitution of electricity for steam power has been effected. People living along the line of the road are very much pleased with the change, and in a future issue we hope to give some data regarding the actual operation of the road.

COMPARATIVE TESTS OF FUEL AND EVAPORATION ON COMPOUND ENGINE NO. 145 (VAUCLAIN TYPE) AND STANDARD ENGINE NO. 138.

	Engine No. 145.				Engine No. 138.			
Engine Dimensions.								
Cylinders, diameters, and stroke	12" and 20" x 24"				18" x 24".			
Diameters of driving-wheels and No	3 pairs = 60⅞" diameter.				3 pairs = 60⅞" diameter.			
Type of engine	Baldwin Ten-wheeler.				Baldwin Ten-wheeler.			
Boiler, diameter and length	Barrel = 54 ; wagon top, 57⅛ and 60¼ x 140⅛.				Barrel = 54"; wagon top, 57⅛ and 60¼ x 140⅛.			
Boiler grate, dimensions	22¼ sq. ft.				22¼ sq. ft.			
Boiler tubes, No. and sizes and surface	200 x 2¼ x 140⅛ x 1,216¾ sq. ft.				200 x 2¼ x 140⅛ x 1,216¾ sq. ft.			
Boiler, total heating surface	1,342¾ sq. ft.				1,342¾ sq. ft.			
Exhaust nozzle, diameter	3⅛".				3⅛".			
Weight of engine, (1) on drivers, (2) gross					(1) 78,700, (2) 106,150, and tender = 173,150.			
	1st day, Nov. 3.	2d day, Nov. 4.	3d day, Nov. 5.	Average.	1st day, Nov. 6.	2d day, Nov. 7.	3d day, Nov. 8.	Average.
Conditions of Tests.								
Coal used on all days	Moshannon Clearfield coal. Same cars used.							
Weather	Fair, no rain	Rain.	Fair.		Perfect.	Perfect.	Fair.	
Condition of engine and fires	Clean fires and tubes and front end swept.	Ordinary working conditions.	Ordinary working conditions.		Clean fires and tubes and front end swept	Ordinary working conditions.	Ordinary working conditions.	
Train hauled. No. of cars	20	20	20	20	20	20	20	20
Train hauled. Gross weight, net tons	819	819	819	819	819	819	819	819
Train hauled. Tare weight, net tons	255	255	255	255	255	254	254	254
Train hauled. Net weight, net tons	564	564	564	564	564	565	565	565
Mileage. Course	Hempstead Crossing and Ronkonkoma and return—twice daily.							
Mileage. Total daily mileage with train	113.78	113.78	113.78	113.78	113.78	113.78	113.78	113.78
Test Figures.								
Coal consumed, in lbs	5,687	6,303	6,607	6,199	9,502	9,835	10,289	9,875
Water evaporated, in lbs	43,104	45,591	47,457	45,384	52,820	Right hand water meter failed, and no correct water readings obtained.	57,101	54,961
Evaporation, lbs. water per lb. coal	7.57	7.23	7.18	7.32	5.55		5.55	5.55
Running time	4° 18½′	4° 07′	4° 06′	4° 11′	4° 19½′	4° 32′	4° 32′	4° 28′
Stoppages	1° 14½′	1° 10′	1° 02′	1° 09′	1° 08½′	1° 26′	1° 19′	1° 18′
No. of stops other than terminal	1	2	nil.	....	1	1	nil.	
Total time with train	5° 33′	5° 17′	5° 08′	5° 19′	5° 28′	5° 58′	5° 51′	5° 45′
Total time engine using steam	3° 47′	3° 46′	3° 46′	3° 46′	3° 55′	3° 52′	3° 39′	3° 48′
Total time safety-valves blowing off	17′ 25″	20′ 30″	5′ 05″	14′ 20″	24′ 45″	4′ 45″	1′ 10″	10′ 13″
Injector feeding regularly. No. of applications	7	10	15	10⅔	10	13	15	12⅔
Average steam-pressure	169.5	170.25	160.4	166.7	130.1	123.9	124	126
Safety-valve set to blow off at — lbs	180	180	180	180	145	145	145	145
Results.								
Pounds of coal burned per train mile	54.4				86.8			
Pounds of coal burned per car mile	2.72				4.34			
Pounds of coal burned per ton, mile per hour of total time	0.01254				0.01847			
Average economy on ton, mile per hour of total time	32.1 per cent.							
Average economy in water per ton, mile per hour of total time	10.7 per cent.							
Average economy per car mile	Fuel, 37 3/16 ; water, 17 3/16.							

Sparks drawn from front end of Compound about ⅛ that from Standard engine.

CHARLES M. JACOBS, *Consulting Engineer*,
192 Broadway, N. Y.

NOTES AND NEWS.

Timber Tests.—An elaborate series of timber tests are now in progress in the Testing Laboratory of the Washington University, under the Forestry Division of the Department of Agriculture.

Susquehanna Tunnel.—The tunnel under the Palisades for the New York, Susquehanna & Western is nearly finished, and before many months trains will be running through it. The last heading of the tunnel was broken through on January 11. The tunnel, which is reached by a branch from the main track back of Fairview, N. J., is 5,070 ft. long, 27 ft. high to

Trial of Armor Plate.—Another successful test of armor plate was made by the Bethlehem Iron Company on February 3. This test involved the acceptance of nearly 400 tons of armor, and the Government will take the plates. These are for the protected cruiser *Puritan*, now being built at Brooklyn. The plate is not Harveyized, and is 18 ft. long, 6 ft. wide and 14 in. thick, tapering to 6 in. in thickness. A 10-in. gun was used with projectiles weighing 500 lbs. each. The first shot penetrated the plate to the depth of 12½ in. There were no radiating cracks, and an even fringe about the hole 4 in. high. The projectile was broken in two. The velocity of the projectile was 1,381 ft. per second. The charge was 132 lbs. of powder. In the second shot 171 lbs. of powder sent the 500-lb. projectile through the air at a velocity of

1,630 ft. per second. The projectile penetrated to the depth of 15⅝ in., but the backing was not disturbed.

The Hungarian Zone System.—It is five years since the Hungarian Government decided to apply the "zone" system to its railways. Taking Budapest as the central point, a circle with 15 miles radius was drawn about it; beyond that another circle was described with 24 miles radius, and so on up to 11 circles. The twelfth and thirteenth circles each included a "zone" of 15 miles, and all the rest of the country made the fourteenth "zone." At the same time fares were reduced, on an average, 50 per cent. A person wishing to go anywhere within the first zone, 15 miles from Budapest or less, pays 20 cents first-class, 16 cents second, and 10 cents third. This rate is doubled for the second zone, anywhere within 24 miles, tripled for the third, and so on to the end. The result is now published. It shows an increase of passengers, upon the whole, to the amount of 216 per cent., and of receipts to the amount of 40 per cent. These returns exceed the most sanguine expectations.

Air Power for Street Cars.—Paris is shortly to try a new experiment with tramways worked by compressed air. There are already electric tramways running from the Madeleine to St. Denis and Pantin with accumulators under the carriage. These are reported to work very satisfactorily and are much more sightly than those of the "trolley" system in use in some of the French departments The new compressed-air machines, which are to be started from the Louvre to Versailles and St. Cloud, are expected to be more satisfactory than either as well as more economical in their working. The locomotives will weigh 18 tons and have a pressure of about 150 lbs., and be capable of drawing three or four cars loaded with passengers. The water of the Seine has been utilized as motive power for the compression of the air. The advantages expected are, besides economical working, the absence of smoke or odor from the machines, and they also, it is said, offer better facilities for dispatching several car loads of passengers at the same time by the same machine.—*Transport.*

Pneumatic Tubes in Chicago.—Pneumatic tubes have recently been laid in the streets of Chicago for connecting the City Hall and the Central Police stations with the office of the City Press Association, the various national and international news associations, and the main stations of the telegraph companies. It is stated that the time of transmission of messages from the points most distinctly separated is but one minute. Circulating in all of the tubes of the system is a continuous current of air, and when it is desired to transmit a package from one station to another, it is merely necessary to place the matter to be delivered in a carrier, which is inserted within the tube and it is instantly off. This is similar, as far as the operation is concerned, to that which is used by the Post Office Department in the city of London, but we have not as yet the information regarding details of the mechanism, so that we can give an accurate technical description of the various valves and appliances which are used. The pipes are laid in a trench in the street at sufficient depth, to get as far as practicable below all pipes and other obstructions. Twenty-nine conduits in a nest are then built of square vitrified clay pipes, into which seamless drawn brass pneumatic tubes are placed. The conduits are laid in and surrounded by Portland cement concrete from 8 to 10 in. thick, thus making it a solid wall of masonry which will not be affected by dampness, heavy traffic, or other causes. The motive power is said to be a jet of steam discharging through an injector. The air is expelled from the tubes, so that when the carrier is placed in position it is forced to its destination by atmospheric pressure. The carrier used is a new device. It is made of flexible leather with an inner wire frame to keep it in proper form, and to allow it to travel around the curves readily. These carriers are 2¼ in. in diameter and about 8 in. long.

Bertrand Rustless Process.—According to an account read before one of the French scientific societies, the Bertrand process of coating with magnetic oxide and enameling iron and iron carburets is much simpler than the better known Bower-Barff process, and is based upon a new discovery in chemistry. It is stated thus: If a thin adherent film of another metal is formed on the wrought iron or on the cast iron, and this iron or cast iron, heated to 1,000°, is exposed to a current of oxidizing gas, the oxygen penetrates through the film, oxidizes the iron or the cast iron, and under these conditions magnetic oxide is the result. The formation of magnetic oxide, thus obtained, continues indefinitely, and the thickness of the coating of oxide increases according to the period of exposure to the oxidizing current, providing the temperature remains at about 1,000°. None of the accounts seen in this country state whether this temperature is by the Centigrade or the Fahrenheit scale.

As to the film of metal deposited in the first instance, it disappears in some obscure way, forming oxides which mingle with the magnetic oxide or volatilize, according to the nature of the metal of which they are composed. M. Bertrand had then to find the best metal and the best method for depositing it on the article to be coated, and he has found that bronze, a mixture of copper and tin, gives from a practical point of view every satisfaction. For depositing this bronze on the wrought iron and cast iron M. Bertrand uses electricity or wet baths, and uses sulphophenolic acid.

The following is the method adopted in the Bertrand manufactory for an oxidation: The article is cleansed (the cleansing is not indispensable), then dipped a few moments in a bath containing a solution of sulphophenolate of copper and tin. The coating of bronze being formed, the article is immediately washed with cold water and dried with sawdust. The article dried is put into a furnace. Oxide forms, and at the end of 15 to 30 minutes (according to the articles) the article is taken out sufficiently oxidized. The coating produced varies from four to eight-thousandths of an inch in thickness.

M. Bertrand uses electricity to ascertain if the coating is of sufficient and uniform thickness, and in doing so he makes use of bells. If in putting the two wires in contact with the oxidized article the bells ring, the current passes—the oxidation is insufficient; if it remains silent, the oxide formed is of sufficient practical thickness, because it prevents the electric current from passing. To obtain tinning on iron, salts of tin are dissolved in a mixture of water and sulphophenolic acid at the rate of 1 per cent. of tin salt and 5 per cent. of sulphophenolic acid. In this mixture the article, which is previously cleaned, is dipped, and is at once covered with an adherent coating of tin, and afterward by the means of rotating brushes in wire and cloth the coating of tin is polished, and a result is obtained which is both effective and cheap.

For enameling iron the direct process is stated to be dangerous to the operator, and impossible in the case of large articles. In the Bertrand enameling, the article is first coated with magnetic oxide, then dipped in borosilicates of lead, colored by metallic oxides, in which is added a little pipe clay in order to give rather more body. The article thus covered cold, by dipping or with brushes, is put into the furnace; the enamel adheres and vitrifies at the usual furnace temperatures used by enamelers. By putting a coating of colored enamel with a brush on a first coat simply plain, it is possible to make any decorations desired, which may be burned in at one operation for out-door vases, etc. These results, due to the first oxidation with magnetic oxide, are remarkable as much for the color as for the tenacity of the enamel and its resistance to rough usage.

PROCEEDINGS OF SOCIETIES.

Liverpool Engineering Society.—At a meeting on January 17 A B. Holmes read a paper on the Public Supply of Electrical Energy; its cost and price. In Liverpool the cost increase in lamps since 1890 has been from 12,000 to 25,000. The load on a station supplying electricity for lighting purposes was shown to be extremely variable, the maximum load in winter being one hundred times greater than the minimum load in summer, the cost of working the plant being much greater in consequence than would be the case were it possible to run the plant under uniform load. It was pointed out that great advantage would be derived from any practicable method of storage, but that the high cost of accumulators at present prevents their commercial use for that purpose. Various methods of charging for the supply of energy were described and compared. It was stated that at the price charged for electricity in Liverpool the cost of lighting by incandescent lamps is approximately double that of gas. It was pointed out that the patents for incandescent lamps having expired, lamps will gradually be improved in efficiency, and that with reduced cost of production it is to be expected that the cost of electric light may in the future not exceed the present price of gas.

DETENTIONS TO TRAINS FROM FAILURES OF PASSENGER LOCOMOTIVES.

The following Table I gives a report of detentions to passenger trains on a prominent road from defects of locomotives for the month of January, 1894. It will repay careful study.

Table II gives the detentions on the same road for the same period for other causes than engine failures. These are enumerated in the first column. We will be glad to receive similar reports from other roads for purposes of comparison.

TABLE I.

STATEMENT OF DETENTIONS TO PASSENGER TRAINS FOR JANUARY, 1894.

Cause of Detentions.	Divisions.									
	A.		B.		C.		D.		Total	
	No.	Time.	No.	Time.	No.	Time.	No.	Time.	No.	Time.
		Min.		Min.		Min.		Min.		Min.
Air pump	2	0	1	10	..	..	1	10	4	20
Bricks	..	..	1	6	..	..	..	..	1	6
Blower disconnected	..	..	1	28	..	..	..	..	1	28
Cock on main drum	1	7	..	..	..	..	..	..	1	7
Driver broke	..	..	..	..	1	18	..	..	1	18
Equalizer broke	..	..	..	..	..	..	1	0	1	0
Engine leaking	..	..	..	..	..	..	1	5	1	5
Eccentric broke	..	..	..	..	..	..	1	85	1	85
Grates	1	6	..	..	..	..	1	7	2	13
Guide bolt	..	..	1	6	..	..	..	..	1	6
Governor pipe on air pump	..	..	1	4	..	..	..	..	1	4
Hose on feed pipe	..	..	..	..	..	..	1	20	1	20
Hose between engine and tender	..	..	..	..	..	..	1	5	1	5
Hot engine truck	1	0	..	..	1	40	1	15	3	55
Hot driving box	..	..	6	113	6	124	7	109	19	346
Hot tender truck	2	23	3	31	6	90	..	..	11	144
Injectors	..	..	1	0	1	55	..	..	2	55
Key in cross-head	..	..	1	45	..	..	..	..	1	45
Key in draw-head	..	..	..	..	..	..	1	57	1	57
Packing	1	0	1	8	..	..	..	..	2	8
Pop valve	..	..	..	..	1	17	..	..	1	17
Reach-rod	..	..	1	5	..	..	..	..	1	5
Stirrup in driving springs	..	..	1	25	..	..	..	..	1	25
Spindle on main-rod	..	..	..	..	..	..	1	45	1	45
Strap on main-rod and both cylinder-heads	..	..	..	..	..	..	1	108	1	108
Steam hose	..	..	..	..	1	25	..	..	1	25
Slide in front end	..	..	..	..	..	..	1	5	1	5
Steam-chest burst	1	46	1	35	..	..	..	..	2	81
Spring hanger	2	20	2	0	..	..	..	..	4	20
Train line pipe	..	..	1	13	..	..	..	..	1	13
Valves broke	..	..	1	10	..	..	..	..	1	10
Valve stem and yoke	..	..	..	..	1	0	1	47	2	47
Water bars	..	..	..	..	..	..	1	5	1	5
Wedge	..	..	1	2	..	..	..	..	1	2
Waste on fire	..	..	1	7	..	..	..	..	1	7
Total	11	1′ 42″	26	5′ 48″	18	6 9″	21	8′ 43″	76	22′ 22″

Division.	Total No. of Trains.	Total No. of Engine Failures.	Total Time Lost.	Per cent. of Failures to No. of Trains.
Division A	2,414	11	1 h. 42 m.	.0045
Division B	3,337	26	5 h. 48 m.	.0078
Division C	2,463	18	6 h. 9 m.	.0073
Division D	2,640	21	8 h. 43 m.	.008

TABLE II.

	Divisions.			
	A.	B.	C.	D.
Detentions by signals	2 h. 42 m.	50 h. 3 m.	35 h. 24 m.	23 h. 51 m.
Total time lost other than engine failures and signals	59 h. 51 m.	121 h. 38 m.	63 h. 49 m.	143 h. 36 m.
Total time lost due to all causes	64 h. 15 m.	177 h. 29 m.	105 h. 22 m.	176 h. 10 m.
Total time made up exceeding schedule time.	14 h. 3 m.	107 h. 7 m.	90 h. 3 m.	124 h. .. m.
No. of hot boxes on cars	....	6	4	6
Time lost due to hot boxes on cars	....	1 h. 48 m.	50 m.	53 m.
No. of passenger trains	2,414	3,337	2,463	2,640
Time lost due to hot boxes per passenger train	....	.0323 m.	.0203 m.	.0200 m.

INTERNATIONAL STANDARDS FOR THE ANALYSIS OF IRON AND STEEL.

ORGANIZATION AND WORK OF THE SUB-COMMITTEE.

At the World's Congress of Chemists, in Chicago, last August, following the papers of Professor J. W. Langley, "On the Work of the Committee on International Standards for the Analysis of Iron and Steel," and of Dr. C. B. Dudley, "On the Need of Standard Methods for the Analysis of Iron and Steel, with Some Proposed Standard Methods," was a brief discussion, which resulted in the reference by that body of the whole subject of standard methods for the analysis of iron and steel, to the Committee on International Standards for the Analysis of Iron and Steel. That Committee, it will be remembered, consists of seven chemists, in each of five different countries—namely, England, France, Germany, Sweden and the United States. The American Committee was appointed jointly by the American Society of Civil Engineers and the University of Michigan, with Professor J. W. Langley, Case School of Science, Cleveland, O., as Chairman. The other members of that Committee were: W. P. Barba, Midvale Steel Works, Nicetown, Philadelphia, Pa.; A. A. Blair, 406 Locust Street, Philadelphia, Pa.; Professor Regis Chauvenet, President State School of Mines, Golden, Col.; Professor T. M. Drown, Massachusetts Institute of Technology, Boston, Mass.; Dr. C. B. Dudley, Chemist Pennsylvania Railroad Company, Altoona, Pa., and Porter W. Shimer, Easton, Pa.

Following the reference of the subject to this Committee, it was decided after consultation to appoint a Sub-Committee, to take up the question of standard methods. The Sub-Committee is constituted as follows: W. P. Barba, A. A. Blair, T. M. Drown, Porter W. Shimer and C. B. Dudley, Chairman.

The Sub-Committee held an organizing meeting at the office of A. A. Blair, 406 Locust Street, Philadelphia, on December 13, all the members being present. The object of the meeting was to map out the work. It was agreed as follows:

1. That Mr. Blair should submit a form of circular to go to the iron and steel chemists of the country, asking for a brief outline of the methods which they prefer, and the reasons for all the important points of their methods.

2. That the work of the Committee should comprehend the recommendation of standard methods to be used as the basis of commercial transactions, and when any of these methods could not be used in steel works in daily practice, on account of time required, an alternative rapid method should be recommended, and its limitations defined.

3. That the members of the Committee should draw up each proposed standard method in writing, with some minuteness, and give the reasons for each important point, these written drafts to be sent to the Chairman, to be duplicated, and sent to every member of the Committee. Later, the points agreed upon are to be edited by some one member of the Committee.

4. That only one element should be embraced in a method.

5. That the first method to be taken up should be phosphorus in steel.

6. Mr. Barba offered to furnish to each member of the Committee, a suitable quantity, not less than a pound or so, of borings of three (3) different kinds of steel—namely, one of from 0.01 to 0.02 phosphorus, carbon about 0.90, and silicon about 0.40; another with phosphorus not far from 0.06, carbon 0.50 to 0.60, silicon 0.25 to 0.30, and arsenic 0.15 per cent. The above two, to be crucible steel. Another sample of open-hearth steel of carbon, 0.90 to 1.05; phosphorus, 0.02 to 0.04; manganese, 0.30 to 0.40; silicon, 0.20 to 0.25; sulphur, 0.02 to 0.04; and copper anywhere below 0.10.

7. Dr. Dudley offered to furnish to each member of the Committee a like amount of borings from a sample of Bessemer steel of from 0.10 to 0.12 phosphorus, carbon about 0.50, manganese 0.80 to 1.00, silicon 0.02 to 0.05, sulphur 0.07 to 0.10, and copper from 0.07 to 0.10. These samples of steel to be used in deciding various questions that may come up in regard to proposed methods.

A very earnest feeling was manifested at the meeting of the Sub-Committee, and the outlook for some good work is apparently very favorable.

Approved: Charles B. Dudley,
J. W. Langley. *Chairman Sub-Committee.*
Chairman Committee on International Standard.

FIRE AT PURDUE UNIVERSITY.

The President and Director of the Engineering Laboratory of Purdue University have issued a circular to its "friends," in which they announce the destruction by fire of the new Engineering Laboratory on the night of January 23—four days after its dedication. In the announcement it is said:

"The fire originated in the boiler-room and spread with great rapidity. Its progress could not be checked until the larger part of a fine building had been destroyed. Three laboratory rooms were burned: the machine-room with its 20 lathes, its planers, shapers, drill presses, milling machines, and its large supply of small tools; the forge-room with its

32 power forges; and the laboratory for advanced work, which contains Purdue's now famous locomotive *Schenectady*, a triple-expansion Corliss engine, and much other apparatus designed for work in steam engineering, hydraulics, and strength of materials. Nothing in these rooms escaped the fire. Not only was all the apparatus lost, but also a large amount of experimental data. The main portion of the building was also consumed. This contained three stories, 50 ft. × 150 ft. It was occupied by drawing-rooms, recitation and lecture rooms, instrument-rooms, offices and a mechanical museum. Some of the furniture and apparatus in these rooms was carried out before the fire took possession, but, as already stated, this part of the building was entirely burned.

"The only portion still standing comprises the wood-room and foundry. These rooms were not damaged except by the temporary removal of the more portable portion of their equipment.

"The incidental losses by the fire are considerable. Members of the faculty have lost books, papers and data; students, their instruments; and many manufacturers in every part of the country, who by gifts or liberal discounts had co-operated in the equipment of the building, have lost their representation there.

"Such a laboratory as the one burned is the result of many influences, not among the least of these being the suggestions of professional friends and the material assistance of those who, as manufacturers and builders, are helping to advance the standard of engineering construction. We gratefully acknowledge the assistance thus rendered, and hope that our success in the past may warrant a continuation of the interest that has heretofore been accorded us."

A course of lectures on the protection of buildings from fire would seem to be in order at this and perhaps at other similar institutions.

RIEHLE MEASURING AND PER CENT. GAUGE.

RIEHLE MEASURING AND PER CENT. GAUGE.

We present to our readers in this issue an illustration of the Riehle measuring and per cent. gauge. An ingenious apparatus of this kind will be readily appreciated by those in charge of testing departments, where the percentage of elongation on tensile specimens of metal is required. It has eight notches 1 in. apart, and is 12 in. long, the 4 in. beyond the notches being laid off and graduated to show the elongation in per cent. without other measuring or figuring.

On the under side is a shoulder running with the length of the scale, so that the lines scribed to show the inches will be across the test piece, at right angles to its axis. The scale is used either with the lines scribed with this instrument, or with pieces laid off with the double-pointed center punch. It is a great time saver, and its use also eliminates the possibility of error in measuring extensions and figuring the percentage of elongation. For pieces laid off in lengths other than 8 in. the percentage scale is in proportion: Thus in 4-in. measurements the reading is doubled, and in 2-in. measurements it is quadrupled. It is made only by Riehle Brothers' Testing Machine Company, Philadelphia, Pa. It is in use by several testing bureaus, among others the Robert W. Hunt & Co. Bureau of Inspection, Tests and Consultation, Chicago; also at the Testing Department of the Illinois Steel Works, North Chicago Works, and the Department of Physical Tests of Riehle Brothers' Testing Machine Company, Philadelphia.

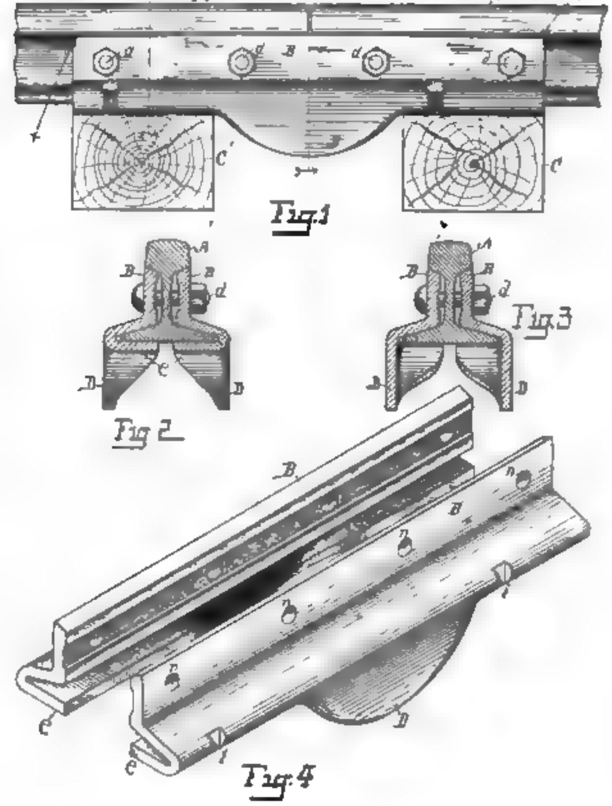
Recent Patents.

BALCH'S RAIL JOINT.

The engravings show, fig. 1, a side view; fig. 2, a transverse section on the line 2 2, of fig. 1, looking toward the right, fig. 3, a similar section on the line 3 3 at the middle of the splice bars; and fig. 4 is a perspective view of the bars with the rails omitted. The inventor describes this invention as follows:

"The splice bars *B* are extended below the base of the rails. The portions *e*, figs. 2 and 4, at the ends of the bars are folded tight against the under side of the base of the rails. The portions *e* so folded rest on the ties *C*, *C'* under the rail, and form a chair for the rail. The middle portions *D* of the splice bars *B*, instead of being folded tight against the under side of the base of the rail, are projected down in a vertical position at the edge of the base and form the trusses *D*, one on either side of the rail. The metal between the truss *D* and the horizontal portion *e* of each bar is left intact. Of course it will be somewhat stretched by the bending of the plate, of which the bar is composed, to the desired form. The metal could be divided between the two parts *D* and *e* and still embody my invention. The bars *B* are bolted to the rails by the bolts *d*, which pass through the bars *B* at and through the web of the rails in the usual manner. Notches are cut in the bars at *i*, fig. 4, to receive the spikes that hold the whole securely to the ties. Bolts could also be inserted through the trusses *D* to hold the bars, but they are not necessary, and I prefer not to use them.

"The upper part of the splice bars *B* are in the usual form of angle bars for that purpose, except that the upper edge, instead of being straight, is curved to leave a small space at



BALCH'S RAIL JOINT.

each end between the bars and the head of the rail. The splice bars fit tight to the heads of the rails at the ends of the rails. This form of construction operates to relieve the joint from shocks, for the reason that when the weight of the trucks of a car or train of cars are on each side of the joint beyond the ties *C*, *C'*, shown, the tendency is to raise the ends of the rails up, the ties *C*, *C'*, acting as fulcrums. The small spaces *x* at the ends of the bars permit this to take place without breaking or straining the joint."

The inventor has recognized the fact that in a rail joint *rigidity* of the joint is not of so great importance as *continuity*. That is, it does not make a great deal of difference whether a joint deflects, but it is of the utmost importance that the ends of the two rails should be held so that their positions will always conform to each other, and the tops of the two rails be in a continuous line. It does not matter much whether this is an absolutely straight line or is slightly curved, but it is of the greatest importance that the end of one rail should not project above that of the other. Thus, if a car or engine is moving toward the left, if when it comes to *A*, fig. 1, the tie *C* and the rail *A* should be depressed, if the latter carries the end of *A'* with it, so that when the wheel gets to the joint at *J* the tops of the two rails are flush, the wheel will roll over the joint and there will

be very little shock or concussion, even though both rails are deflected at the joint. If, however, the rail A is depressed independently of A', and when the wheel reaches the end of A' it projects one-sixteenth of an inch or more above A, there will be a shock proportionate to the difference in height of the ends of the two rails. A similar result would follow if the tie C was rigidly supported and C' was unsupported, and would be depressed when the end of the rail A' was loaded. In that case the wheel would drop from an elevation at the end J of the rail A and fall on A', whatever distance the tie C' could be depressed, and a concussion and battering of the end of the rail A' would result. If, however, the ends of the two rails are securely held, so that their top surfaces will always be exactly flush with each other, then, no matter whether either or both are deflected, a smooth joint will be maintained nevertheless.

It may be added that absolute rigidity in track is impossible. Of course, with very heavy rails and plenty of ballast and thoroughly good maintenance there will be more rigidity than is possible with light rails, little or no ballast, and neglect of repairs. The deflection of rails must, however, be recognized. There will always be deflection, and it should be provided for. The inventor of this rail joint has, therefore, it is thought very wisely, made provision for this, and has made the top edges of his splice bars curved, so that they fit tight to the rails only at their ends, and there is a little space or clearance between the ends of the bars and the under side of the heads of the rails. This allows deflection of the rails to take place without undue strain on the bars. The bars form a bridge extending from one tie to the other, which is made as rigid as possible to support the ends of the rails, but if one of the abutments should be depressed the consequent deflection of the rails does not bring an undue strain on the bridge. The rigidity of the bridge, it will be seen, is obtained by the form into which the lower flanges e e are bent, as shown at D.

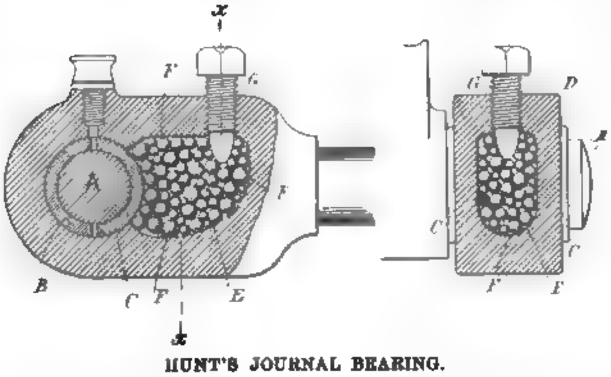
Altogether this invention seems to be a very promising one. The inventor is Mr. Frank C. Balch, of Kalamazoo, Mich. His patent is No. 509,422, and is dated November 28, 1893.

HUNT'S JOURNAL BEARING.

Mr. Charles W. Hunt, of New York, has recently patented the ingenious device shown in the engravings for "setting up" the bearings of journals, such as crank-pins and other journals where a "stub-end" or "strap-end" is ordinarily provided.

Fig. 1 is a longitudinal and fig. 2 a tranverse section of this arrangement, which is described as follows in the specification:

"The crank pin or shaft at A is provided with the brasses



HUNT'S JOURNAL BEARING.

or boxes B C, and these are held in any suitable support, such as the end of the connecting-rod D, and adjacent to one of the boxes there is a cavity E into which are inserted balls or spheres F, preferably of hard steel. A series of balls are used of various diameters introduced into the cavity adjoining the box or brass that is to be set up, and a screw G is provided, sometimes having a tapering point, that passes into the hole through which the balls may be introduced, and such screw pressing upon the balls causes them to come into intimate association and bearing one upon the other and also upon the box that is to be set up, and these balls slide one upon the other as pressed upon by the screw, so as to exert the necessary force against the whole of the outer surface of the box or bearing, to press the same to its position. By making use of balls or spheres of different sizes I am enabled to obtain a substantially fluid condition, so that the screw G when it is pressed upon the spheres causes one to roll upon another, and a pressure to be exerted around all sides of the cavity E and against one side of the box C, so as to press the same with the desired force against the crank-pin or shaft A. It is preferable to make the opening for the screw G sufficiently large for the balls to pass freely through the same and into the cavity, and to introduce lubricating material with the balls for the twofold purpose of preventing rust and for causing the balls to slide or roll freely one upon the other under the action of the screw G, as the same may be set up from time to time; and it will be observed that there is no hammering or loosening action exerted upon the screw G. Hence the same is not liable to turn or to become loose, and when the parts have come to a proper bearing any wear or looseness can be taken up with great facility by a slight turn of the screw G.

"In practice," the inventor says, "that when balls of the same size are used they pile with regularity similar to pyramids and wedge into the cavity, and there is not a tendency to press in any direction; but when the balls are of different sizes they will not pile or pack, but slide and move one on the other similar to a liquid, and hence press in any direction within the cavity when acted on by the screw."

The invention is a very ingenious one, and should practical experience confirm the promise of its usefulness, it may effect an entire change in the construction of strap ends, which have held their own for more than a century.

The inventor is Mr. Charles W. Hunt, the well-known manufacturer of hoisting and conveying machinery, of 45 Broadway, New York. The number of his patent is 512,826, and the date is January 16, 1894.

SALVETER'S METAL DRAFT-SILL FOR CARS.

"The main object of this invention," it is said in the specification, "is to provide a draft-sill that is light and compact, and is at the same time capable of withstanding the severe shocks and strains to which this part of cars is commonly subjected. For this purpose the sill is made of metal instead of wood, and such portions of the sill as would bear little or no portion of the strains is cut away, and certain flanges and other appendages are provided, preferably cast integral with the sill and calculated to greatly increase the strength without adding materially to the weight and bulk thereof."

The general construction which is proposed will be understood from the engravings without other description. Fig. 1 is a longitudinal vertical section of the draw-gear of a car drawn on the line 1—1 of fig. 2, and shows one of the metal draw-sills as seen from the inner side. Fig 2 is a transverse vertical section on the plane of line 2—2 of fig. 1, looking from the left in fig. 1. Fig. 3 is a plan view of a pair of the draft-sills, showing one of them in section, this section being on the plane of line 3—3 of fig. 1. Fig 4 is a side elevation of one of the sills, as seen from its outer side.

While the general construction of these draw-sills will be apparent from the engravings, the inventor's description of some of the special features will be quoted. The specification says:

"Extending horizontally between the upper portion of the front and rear draw-lugs 26 and 27, and projecting at right angles from the inner surface of each sill near its upper edge, is an offset or flange 36, along the under surface of which are moved the upper edges of the respective draw-followers 30 and 31 when the car is drawn forward or backed, and the draw-spring is depressed, these flanges 36 serving to confine said draw-followers and prevent their rising upward out of place. The flange or offset 36 is cast integral with the sill, both for simplicity and greater strength.

"Extending horizontally between the lower portion of the front and rear draw-lugs, and corresponding to the flanges 36 just described, are the removable tie-plates 37, which, after the draw-head, draw-spring, and draw followers have been inserted in their proper places, are placed against the lower surface of the draw-lugs and securely held to said lugs by bolts 38 passing through vertical perforations (fig. 3) in the front and rear draw-lugs 26 and 27. These tie-plates hold the draw-followers and co-operating parts in place, and prevent the same from dropping or being forced out of position downwardly.

"It will be observed that the strain on the draft-sill will ordinarily be greatest in the vicinity of the draw-followers, and will diminish toward the rear portion of the draft-sill, which rear portion is therefore made of decreasing height. A further saving of metal and lightness of the sill are secured by cutting away the middle portions of the same in the spaces between the columns 17 before described, as clearly shown in figs. 1 and 4. For a like purpose a considerable part of the middle portion of the columns 17 may be cut away, as clearly shown in figs. 2 and 4.

"The front ends (or ends furthest to the left in fig. 1) of the draft-sill 13 are preferably turned slightly inward, approach-

ing more closely toward each other and toward the draw-head than the remaining portions of the sill.

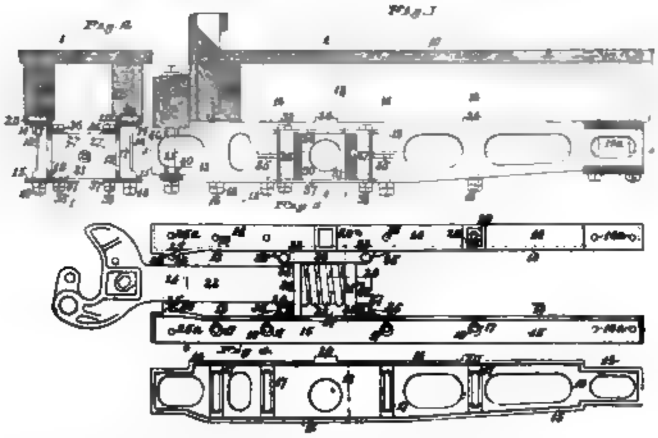
"Extending vertically across the inner surface of the sills near the front end just described I provide, preferably cast integral with the sills, raised ribs 40, having semi-cylindrical vertical grooves in which rest the bolts 25 which secure together the deadwood 23, carrier-iron 24, and front ends of the sills, as above described. It will be evident that the space between the sills at the front end is, in this manner, greatly contracted, the object of which construction is to leave only a very limited play for the draw-head, thereby guarding against breakage of the reduced part or tail pin 29 and the draw-followers 30 and 31, the shock of a sideward thrust of the draw-head being spent on and resisted mainly by the bolts 25 just described."

The inventor does not say in his specification whether he contemplates making these draw sills of cast iron or cast steel, but obviously they must be made either of the one metal or the other.

The patentee is the well-known car-builder, Theodore C. Salveter, of St. Louis. The number of his patent is 512,329, and the date is January 9, 1894.

LOCOMOTIVE ENGINE.

There is perhaps no problem in connection with locomotive engineering, if we except the valve-gearing on which so much ingenuity has been exercised, as on that of providing a flexible driving-wheel base. By that is meant an arrangement of driving-wheels which will permit them to adjust themselves



SALVETER'S METAL DRAFT-SILL.

to the sinuosities of curves and assume radial positions in relation thereto. A very large number of such inventions have been proposed of varying degrees of practicability and impracticability—chiefly the latter. Messrs. Richard Klein and Robert Lindner, of Chemnitz, Germany, have recently taken out an American patent for an ingenious arrangement, which is not without some promise of success.

Fig. 1 is a transverse section on the lines *t c* and *v w* of fig. 3, which is a plan of the running gear of a six-wheeled coupled locomotive. Fig. 2 is a transverse section in the middle of the leading axle on the line *x y* of fig. 1.

The invention relates to what is called in the specifications "displaceable" axles. In the illustrations herewith only one such displaceable axle—the leading one—is shown, but the inventors describe an engine in which both the front and trailing axles are arranged in this way, and the intermediate axles also have some capacity for lateral movement.

The displaceable axle consists of what the inventors call an "inner core," which in reality is a shaft *A* which is attached to the frames *F F* by journals *J J* of the ordinary type. This shaft is driven by cranks and coupling-rods in the usual way. The wheel centers, which are attached to this shaft, are each made with a hollow sleeve, *B*, which extend from the wheels to the longitudinal center line of the engine, and are then bolted together by suitable flanges *B'*, shown clearly in figs. 2 and 3. The central shaft or "core" is provided, at its center, with a spherical or "ball" bearing *a*, which is journaled in a corresponding spherical bearing *b*, fig. 1, made in two parts and secured to the sleeve *B*. The extremities *c c* of the bolt have bearings *r r*, which are enclosed in slots *d* in such a manner that they have a certain play transversely to the track, and may also turn around the axis of the bolt, but have no play at all, or but very little, in the longitudinal direction of the track or circumferentially to the shaft. It will be understood, therefore, that while the sleeve *B* may be displaced laterally on the shaft or axle proper *A*, and may assume a position at an angle to *A*, yet in no case will the axle or shaft *A* be able to rotate without the sleeve *B*, but both parts will always rotate together. Rings *f f* are inserted within the sleeve and are firmly secured to the same. These rings enclose and hold part of the bearings *b*, which can move in the sleeve a certain distance transversely to the engine or in the direction of the axis of the shaft or axle *A*. The rings *f* also limit the transverse displacement or movement of *b* in the sleeve. A small annular space *e* is left between the rings *f* and bearing *b*, in order to allow for the movement of the latter. Two coiled springs *g*, bearing with one end against a shoulder of the sleeve *B*, and with the other end against the ring *f* and the bearing *b*, constantly tend to bring the sleeve *B* and the wheels *W* into the normal position shown in fig. 1.

The sleeve *B* has two collars or journals *n*, the surfaces of which are also turned to a spherical form. To these rings or

Fig 1

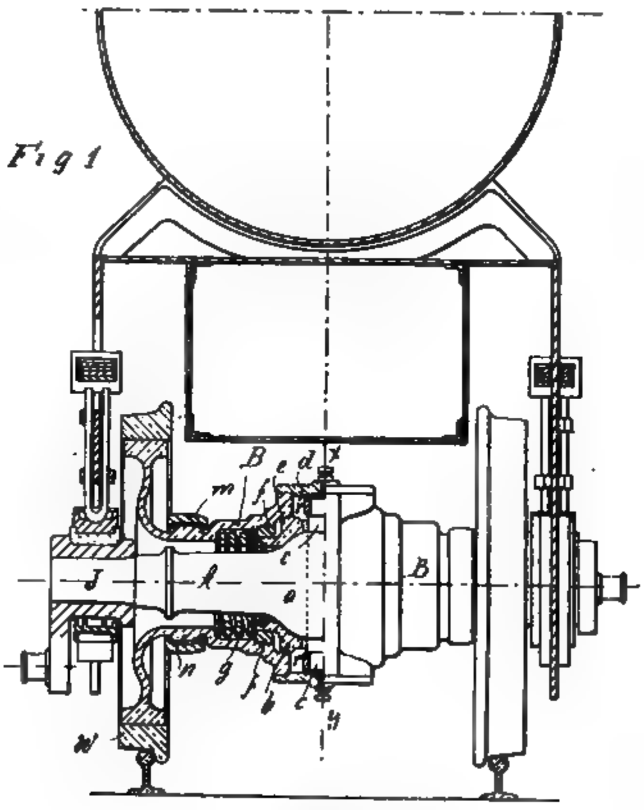
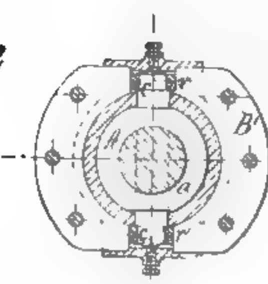


Fig 2



KLEIN AND LINDNER'S LOCOMOTIVE.

straps *m* are loosely fitted, and to the rings connecting-rods *m'*, fig. 3, are secured, which is jointed to a bolt *l'*. This bolt is connected to a coiled spring *h*.

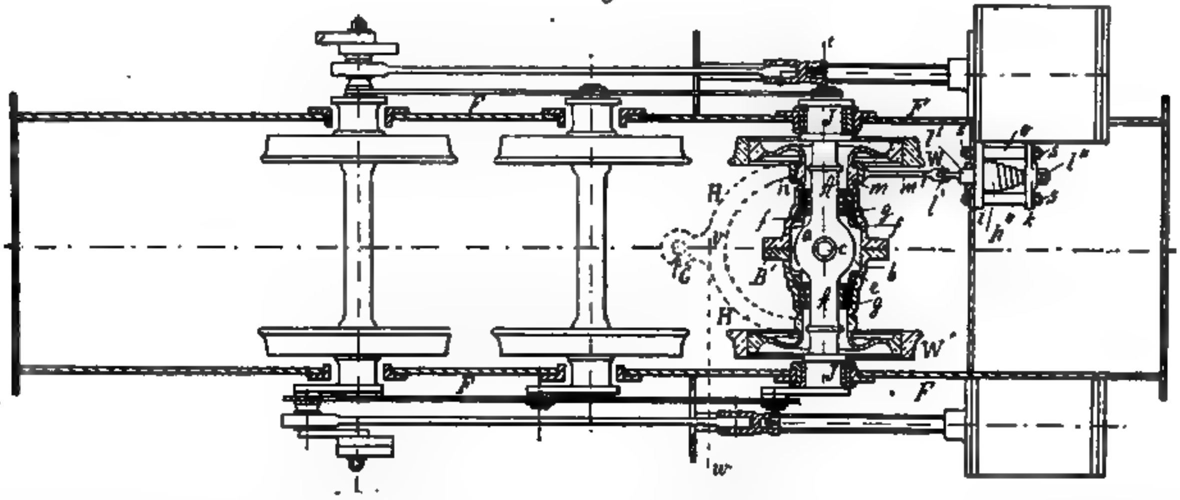
In their specification the inventors describe the action of their engine as follows:

"When the engine enters a curve, the core *A* will remain perpendicular to the longitudinal walls of the frame *F*. The sleeve *B*, however, will assume such a position that its axis will be normal to the rails—*i.e.*, directed toward the center of the curve. It will be obvious that this adjustment of the sleeve *B* carrying the wheels will be automatic, the rails acting as guides for the flanges of the wheels. At the same time the sleeve *B* and core *A* will be displaced somewhat in relation to each other, transversely to the track. One of the springs *g* will be compressed by this movement, and the spring *h* will likewise be compressed. When the track is

again in a straight line, the spring g, which has been compressed, will expand and bring the sleeve B back to its central position, as shown in fig. 3. The spring h will likewise expand and thereby restore the sleeve B to the position in which its axis coincides with that of the core A. It will be obvious that the running of the engine through sharp curves will be considerably facilitated by the automatic adjustment of the wheels tangentially to the rails.

"Another advantage of our improved construction is that each of the wheels connected to one sleeve B carries exactly the same load, as the entire load borne by one axle rests upon the center of the sleeve."

Fig. 3



KLEIN AND LINDNER'S LOCOMOTIVE.

It does not seem entirely certain though that the engine will work exactly as the inventors expect. If, for example, it was running with the leading wheels W W', fig. 3, ahead, and W should come in contact with the outer rail of a curve, the effect of the pressure of the rail against the flange of this wheel would be to push it back and compress the spring h. If this should occur the axis of the wheels W W', instead of assuming an inclined position, which would be radial to the curve, would be inclined in the reverse way. This obviously would be dangerous. A much better plan would appear to be to attach the straps or rings n on the bearings m to a frame similar to that of a Bissel or pony truck, indicated by the dotted lines, and pivoted to a center pin at G. If the leading wheels were then displaced laterally by the pressure of the flange of either wheel against a curved rail, the frame H H moving about the center pin G would cause the axis of the wheels W W' to assume a position radial to the curve.

The dotted lines, H H, have been added to the engraving accompanying the patent specification.

The number of the patent is 511,531, and the date December 26, 1893.

COLE AND GRIEVES DRAW-GEAR FOR CARS.

The accompanying engravings show an analogous invention to that of Mr. Salveter's. Its object, the inventors say, is to strengthen the framework of cars to resist the shock of impact in coupling.

Fig. 1 represents a longitudinal section of this draw-gear, fig. 2 a plan, and fig. 3 an end view of the block 5.

"In the form of construction designed by the inventors of this arrangement, 11—11, fig. 2, represent the usual center sills commonly used on cars. 10 is a central timber not usually used in constructing freight cars of this class. It stands between the timbers 11—11, to which it is bolted by a series of transverse bolts. The end of the timber 10 abuts against the end sill 9 in its center and between the truss-rods 7—7. The under side of the timber 10 is notched at 14—14, fig. 1. 1—1 are the drawbar timbers of the car, 2 the coupling-head and bumper; 3 the bumper-spring; 4 the bumper follower-plate, upon which the bumper spring rests.

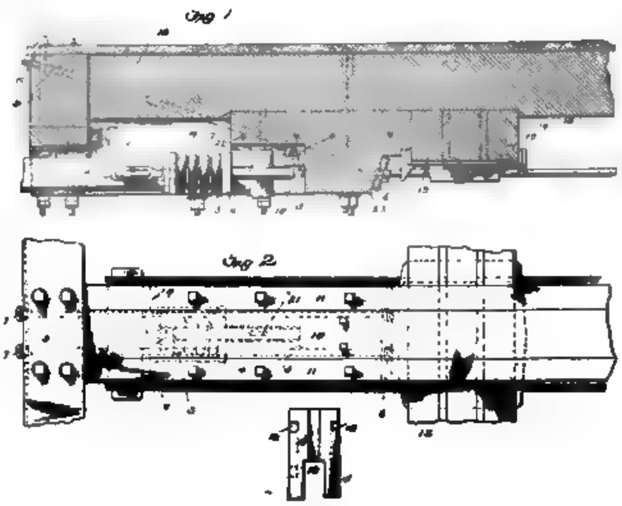
"5 is a filling block which stands between the rear ends of the drawbar timbers 1—1, to which it is bolted by horizontal bolts 22—23 passing through said timbers and block. The rear ends of both drawbar timbers and block 5 are made of the same shape, and at the lower corner are provided with a notch having an inclined surface 23.

"6 is a washer plate bearing against the inclined notch 23 and extending across the rear ends of both drawbar timbers and block 5.

"7—7 are two truss-rods which pass through the plate or washer 6, through the grooves in the sides of the block 5, and through slots in the sides of the central timber 10, and through the end sill 9, and washer 8. Upon its extremity a nut is screwed which bears upon the washer 8.

"The block 5 extends slightly above the drawbar timbers 1—1 which fits into the forward end of said notch. 13 is a cross-brace timber which stands immediately behind the block 5 and the drawbar timbers 1—1, and against which they abut; it fits on its upper edge into the other end of the notch 14, and, together with the block 5, occupies said notch.

"It will be readily seen that when a blow is struck upon the coupling, the shock will be received by the bar 2, and imparted to the plate 4, and drawbar timbers 1—1 and the block 5, both of which abut upon the cross timber 13, which is notched into the timber 10. Timber 10 being bolted by a series of horizontal bolts to the frame timbers of the car-body, the strain put upon the drawbar timbers 1—1 and the block 5 will also be imparted to the truss-rods 7—7, through the plate 6, and by said bolts to the end sill 9, and to the frame of the car. It will thus be seen that all shocks upon the couplings will be equally distributed throughout the car frame, and the maximum strength secured."



COLE AND GRIEVES' DRAW-GEAR.

The inventors are Francis J. Cole, Mechanical Engineer, and Edward G. Grieves, Master Car-Builder of the Baltimore & Ohio Railroad, both of Baltimore. Their patent is numbered 511,588, and its date is December 26, 1893.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

Formerly the RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

The American Railroad Journal, founded in 1832, was consolidated with Van Nostrand's Engineering Magazine, 1887, forming the Railroad and Engineering Journal, the name of which was changed to the American Engineer and Railroad Journal, January, 1893.

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NEW YORK, APRIL, 1894.

EDITORIAL NOTES.

A CURIOUS remark was made by a railroad man at the last meeting of the New York Railroad Club. One of the speakers had alluded to the fact that the coefficient of friction between the axle and the brass was dependent to a great extent upon the quality of the materials and oil used, and that it had considerable to do with the train which an engine was capable of hauling. The railroad man remarked that "practical railroad men had other things to attend to besides looking after coefficients of friction." It would seem that if there were any one thing that the practical railroad man should make himself familiar with, it is this very thing; and possibly if the man who made the criticism would pay more attention to these trifles his engines would haul longer trains and hot boxes would be of less frequent occurrence.

IF the committee of the Master Car-Builders' Association on Compressed Air and Hydraulic Machinery have any kind of luck, it should be able to present a report full of interest and value to the railroads. During the year that is past THE AMERICAN ENGINEER has devoted considerable space to the description and illustration of hydraulic and pneumatic hoists. In every case where they have been used the report has been one of saving of time and expense. The first cost of a pump or compressor is comparatively little, and the wear upon them, for the service required, almost infinitesimal. An ordinary boiler feed or fire-pump is amply sufficient to maintain a water pressure equal to the demands of shop work, and an ordinary air-brake pump is an excellent compressor. The rest of the expense is for piping, hose, and the construction of the cylinders used as hoists. They save a deal of hard lifting, and cut down the time required for moving heavy weights by a good large ratio.

HIGH-SPEED LOCOMOTIVES.

AT the February meeting of the Western Railway Club, Mr. C. H. Quereau, Engineer of Tests of the Chicago, Burlington & Quincy Railroad, read a very interesting and able paper on Steam Distribution for High Speed Locomotives, which, we regret, is too long for reproduction in our pages. In his introductory remarks he says very justly that "not every one interested in the subject has had opportunities of obtaining the information given by the indicator, or reading indicator cards." To this we will add the statement that it is a matter of constant surprise and regret to editors of newspapers and others that those occupying positions in which there is abundant chance of getting information, so seldom make the best use of such opportunities. Mr. Quereau has availed himself of the information which was within his reach, and has contributed a paper which every locomotive superintendent should read carefully. It is safe to say that, if all who occupy such positions should read and understand it, the companies which employ them would be profited thereby. It is true that there is nothing strikingly new in the paper, but neither are the Scriptures new, and yet the texts contained therein supply the basis of many sermons, some of which are dull and others stimulating. Mr. Quereau's mechanical sermon belongs to the latter class.

The corollary deduced from the discussion is that for fast-running engines there must be ample provision for the steam to get into the cylinders to do its work and get out of them after it has done it, and it is pointed out that it is easier to do this with big wheels than it is with little ones, at the same high speeds.

The author of this paper has adopted the excellent plan of "outlining," in a clear and elementary way, the processes by which he drew his deductions. He gives an explanation of an indicator diagram and what it "indicates," and how the indicated water per H.P. per hour is determined. Now, while there is no doubt many of his readers are more or less familiar with all these general principles, yet it is equally certain that many are not. Those who are can easily skip this part, and those whose minds are rusty will be refreshed, and those who are ignorant will be enlightened.

It is remarkable how rare the faculty is of understanding a subject thoroughly, and then being able to assume the mental attitude of those who are entirely or partially ignorant of it. In an account of the life of the late Professor Tyndall, written by Herbert Spencer, he describes very happily and lucidly this faculty. After referring to Tyndall's wonderful capacity as an "expositor," Spencer says:

"Good exposition implies much constructive imagination. A prerequisite is the forming of true ideas of the mental states of those who are to be taught, and a further prerequisite is the imagining of methods by which, beginning with conceptions they possess, there may be built up in their minds the conceptions they do not possess. Of constructive imagination as displayed in this sphere, *men at large appear to be almost devoid.*" *

The author of the paper before us seems to have this "constructive imagination" in a high degree, or at least to an extent sufficient for the writing of a very clear paper. This is shown in the paragraph on boilers, in which he explains the reasons why high speeds demand a greater steaming capacity than slow speeds. He might have added that the speed of locomotives is always limited by the capacity of the boiler to make steam, hence the maxim which has been laid down, that "*within the limits of weight and space to which it is necessarily confined, a locomotive boiler cannot be too big.*" Or the princi-

* We have italicized these words because they confirm so vividly editorial experience.

ple is more briefly stated in the injunction, always "*make the boiler as big as you can.*"

Regarding balanced valves, the experiments of Mr. Philip Wallis in 1886 are quoted, in which it was shown that there was a saving of 3.8 H.P. by balanced as compared with unbalanced valves.

Of the effect of speed on the average steam pressure in the cylinders, the paper says: "Even though the cut-off and boiler pressure remain the same, this pressure decreases as the speed increases; because of the higher piston speed and more rapid valve travel, the steam has a shorter time in which to enter the cylinders at the higher speed." This is demonstrated with admirable clearness by a series of indicator diagrams, which show that under the same conditions, excepting that the speeds were different, the average pressure in the cylinders varied from 51.5 lbs. per square inch at a speed of 17 miles per hour to 36.3 lbs. at 66 miles per hour. The point of cut-off appears to be about 5½ in. of the stroke. As the author of the paper says: "The resistance of the train and the load increase, and the power of the locomotive decreases with increasing speed, till the resistance and power are equal, when the speed becomes uniform." Now it might seem that the average cylinder pressure could readily be increased by simply admitting steam during a longer period of the stroke; but if we do this with heavy trains and high speeds the boiler will not produce steam enough to supply the cylinders, and the steam will also be used more wastefully if it is expanded less. Attention is called in the paper to the fact that the main difference of the diagrams taken at different speeds "lies in the higher steam lines at the lower speeds"—that is, the steam is maintained during the period of admission at higher pressure at slow than at high speeds. During the latter the steam is "wire-drawn" as it enters the cylinder. One of the purposes of the paper is to show that this wire-drawing may be reduced by the use of larger drivers, Allan valves, increased valve travel, and greater length of steam-ports, and that there will thus be a material increase in the power developed, with a saving of fuel.

These are the recommendations for the steam side of the pistons. Of course the propelling power of a locomotive is represented by the algebraic sum of the positive pressure on the steam side of the pistons and the negative pressure on the exhaust side. The latter is produced by contracted exhaust nozzles, which are necessary if the boiler capacity is small, by excessive lead, which is needed if the engine is overbalanced, and by inside lap or the want of inside clearance. Consequently ample boiler capacity, which will permit of the use of large exhaust nozzles, is recommended, with proper adjustment of lead to reduce compression and inside clearance.

It would be interesting to know to what extent a reduction of compression would be economical, provided there was no momentum of reciprocating weights to be counteracted. There can be no doubt of the fact that all the power required to force the exhaust steam through the exhaust nozzles is waste effort, so far as the action of the steam and pistons is concerned; but an amount of compression just sufficient to fill the steam passages and clearance spaces with steam of boiler pressure is not a waste, but, on the contrary, the late Mr. Hoadley, and, we believe, Professor Thurston have suggested that it might be economical to regulate the power of engines by altering the amount of compression instead of changing the point of cut-off.

The subject of balancing engines is now receiving a great deal of attention, and several schemes are now, or soon will be, before the public, by which the reciprocating parts will be self-balanced. It would be interesting to know to what extent compression should be carried, if the necessity of counteracting the momentum of the reciprocating parts no longer existed.

In this problem of the locomotive, as in most other human affairs, the question of proportion is of the utmost importance. It is true that with large wheels it is easier to maintain the pressure of steam in the cylinders during admission, but large wheels are heavier than small ones—they require larger and heavier cylinders and pistons. All the connections of these, the axles and frames and other parts, must all be larger and heavier; consequently if the wheels of an engine of a given weight are made large and heavy, the boiler must be lighter and smaller, which means contracted nozzles. Obviously there might be more loss from the latter than gain from the use of large wheels. There is doubtless some relation between the size of the wheels and size of the boiler which will give the best attainable results. This proportion is the problem which designers of locomotives have to work out.

The conclusions that Mr. Quereau has drawn are, that for fast-running the wheels and boiler should be big and the steam pressure high, which in a certain sense are contradictory conditions, because the bigger the wheels the smaller the boiler must be with an engine of a given weight, and the higher the pressure the greater the weight, and consequently the smaller the size of the boiler. The problem, then, is to so proportion these organs and functions as to get the best results.

Considering the importance which is assigned to the maintenance of a high steam pressure during admission, and reducing the back pressure on the exhaust side of pistons, it is remarkable that some of the old or modified forms of old valve gear, with separate cut-off valves, have not been revived. In some of these the exhaust was controlled by the main or lower valve, which had a constant travel, and the admission was governed by an upper or cut-off valve, with a variable throw. Thomas Winans, of Baltimore, constructed a valve gear of this kind, which was applied to an engine called the *Centipede*, which was built about the year 1855 or 1856. The engine had eight wheels coupled of 42 or 43 in. diameter, and a four-wheeled truck in front. The front end of the engine rested on a roller in the center of the truck, so that the truck could move laterally in relation to the engine. This, it is thought, was the first use of a lateral moving truck under locomotives. The valve gear consisted of a lower main valve which was worked by a forward and a back-motion hook. On top of this was a sort of gridiron-valve with two or three admission ports for each end of the cylinder. It was worked by an ordinary link. With this gear the steam-ports could be opened wide at 2 or 3 in. of the stroke, and varied for each point up to full stroke, and in each case gave a full port opening. The lower valve controlled the exhaust, and having a constant travel for all points of cut-off, there was a very small amount of back pressure. This engine was operated on the Baltimore & Ohio Railroad for a number of years. The valve gear gave the most perfect theoretical movement of any locomotive gear the writer has ever seen, but the valves were large, and gave trouble from cutting. A balanced arrangement was put on them, but it is thought was never satisfactory. Possibly with some of the present approved methods of balancing valves such a device might be made successful.

Another peculiarity of the engine was that the cab was in front. The boiler was the same as those used on the famous "camel" engines of that date, excepting that it was somewhat longer.

NEW PUBLICATIONS.

THE "PRACTICAL ENGINEER" POCKET-BOOK AND DIARY, 1894. 227 pp., 5¼ × 3½ in. Edited by W. H. Fowler. Technical Publishing Company, Manchester, England.

This class of books always cause a reviewer dismay. The difficulty of doing them justice is somewhat like that which would be encountered in reviewing a dictionary. The book

before us is edited by the editor of the *Practical Engineer*, a newspaper published in Manchester, England. It begins with some explanations relating to mensuration, which are followed by an excellent table of decimal equivalents of sixty-fourths, which is followed by a table of polygons giving their names and various dimensions. Perhaps most of our educated readers think they know the names of various polygons, yet probably it will be new information to many of them that a twenty-sided figure is an "eicosagon."

After the usual tables found in such books there is a division devoted to Steam Boilers, which occupies 44 pp. and gives a great deal of interesting and useful information. This is followed by The Steam-Engine, 66 pp.; Transmission of Power, 22 pp.; Hydraulic Engineering, 10 pp. This is followed by miscellaneous data about a variety of subjects, and is succeeded by divisions on Gas and Oil-engines, 16 pp. The book concludes with notes on patents and a diary and blank pages for memoranda. The book is of convenient form and size for pocket use, and is strong on the subjects of boilers, steam, gas and oil-engines.

A Practical Treatise on the Steam Engine. Second Edition. By Arthur Rigg. Spon & Chamberlain, New York. 379 pp., letter-press, 10½ × 8¼ in., 103 plates.

Those readers who are not acquainted with the first edition of this book are ignorant of one of the best treatises on the subject in the English language. The general scheme of the book is indicated by the observations in the preface, in which the author says: "Strange it seems that in our own country there still lingers among many clever practical men a profound distrust for theory, while in foreign countries engineers are too apt to depreciate practical experience. One view is the legacy of ignorance, the other the pride of intellect; and both are equally pernicious."

On this postulate the author has constructed his treatise, which, he says, was "written to describe various examples of Fixed steam-engines, without entering into the wide domain of Locomotive or Marine practice; to give details of construction, with the principles by which their relative proportions may be calculated, and to investigate the more modern applications of science to the subject. In order to avoid mathematical forms of expression, which are unfamiliar to practical men, the graphic method of calculation is brought into prominent use, and it will be found that with very little attention a busy engineer can adapt this system to ordinary calculations, for it has the merit of extreme simplicity, and can be employed even when more elaborate systems fail."

The difference in the size of the two editions is indicated by the fact that the first had 312 pp. of letter-press, and the new one has 379. The number of plates in the old one was 94, whereas the last has 103. There are 24 chapters on the following subjects: Systems of Measurement; Matter, Force and Motion; The Horizontal Steam-Engine; Cylinder, Piston and Piston-Rod; The Slide-Valve (Theoretical Investigations); Slide-Valves (Construction); Lubrication and Lubricators; Connecting-Rods; The Cross-Head or Motion Block; Parallel Motions; Cranks and Eccentrics; Influence of Cranks and Connecting Rods; Shafts, Keys and Hammers; Pedestals and Wall-Boxes; The Fly-Wheel; Steam-Engine Governors; Condensers for Steam-Engines; Spanners and Nuts; Steam-Engine Indicator; Steam-Engine Indicator Diagrams; Influence of the Velocity of Reciprocating Parts of Steam-Engines; Description of Illustrations; Modern High-Speed Steam-Engines; Heat and Steam.

The most noteworthy portion of this book is the part relating to the influence of the velocity of reciprocating parts of steam-engines. A preliminary chapter elucidates very clearly the laws which govern matter in its various forms and motions. Probably there are very few engineers who could succesfully pass a rigid examination on these subjects, or who have a perfectly clear understanding of them. The author of the book before us has given his readers an admirably clear chapter which is not hard reading, and which requires only a knowledge of elementary algebra to understand it. Another chapter, on the Influence of Cranks and Connecting-Rods, contains an admirably clear, graphical elucidation of this somewhat intricate subject. These two chapters, in connection with the one on the influence of the velocity of the reciprocating parts, are, perhaps, the most satisfactory and conclusive dissertation on the subject that has ever been written, and no student or engineer interested in the construction of the steam-engine should be ignorant of this general subject, which Mr. Rigg has explained so clearly. The other portions of the book can also be commended very highly, and this and Holmes's "Treatise on the Steam-Engine" are the books which it is always safe to advise students, mechanics and engineers to study.

The type, paper and printing are all good. The only criticism required that is unfavorable is with reference to some of the engravings. Some of these are much worn, and should have been re-engraved for the new edition. Reference may be made to fig. 108 and figs. 196–222, which are unworthy, and should be condemned and replaced by new ones.

Locomotive Mechanism and Engineering. By H. C. Reagan, Jr., Locomotive Engineer. 296 pp., 7¼ × 5 in. John Wiley & Sons, New York.

This book belongs to the class which are called "practical," and has some of the characteristics of that kind of literature. It has never been quite obvious why an author, when he undertakes to write anything "practical," omits the definite and indefinite articles. They often do so, however, and such books are generally written in what may be called railroad English. As an example of this, the following opening sentence of our author's second chapter is quoted, the words which he has omitted being printed in brackets. He says: "The steam-pipes in [the] smoke-arch are connected to the end of [the] steam or dry-pipe, which is called [the] bulkhead or tee-pipe, and [is] joined to [the] steam passage in [the] saddle, as in fig. 5." Just why it should make writing appear to be more "practical" to omit some of the words which every man would use in conversation is not clear, but such omission is very common in the literature written for and by railroad men. This, however, is a minor defect in a book which has very much to recommend it.

Another peculiarity of what are called practical books is that authors of such literature do not seem to aim at strict accuracy or lucidity in their statements. This is often a serious defect. As examples of this we may quote from the first chapter on the locomotive boiler, which gives a very brief and incomplete description of its construction. It is said, for example, that "the Belpaire boiler uses *radial* stays." As a matter of fact, in nearly all Belpaire boilers, and in the one represented in the author's engraving, the stay-bolts are not radial, but are parallel to each other, the plates being flat. He also says "the mud cannot accumulate on the crown-sheet as it does when using crown-bars." This is hardly true—it can accumulate there as easily in one boiler as in the other, the only difference being that it can be removed easier from the Belpaire crown-sheet than it can be from one covered with crown-bars. He also says that "the sheets (of a Belpaire boiler) can adjust themselves to each other better under different pressures and change of temperature." It is not quite clear what this means. He probably has in his mind the fact that the flat top plates of a Belpaire fire-box have more flexibility than curved plates would have, and they can thus distribute the strains due to the steam pressure, which they must resist, more uniformly on the stay-bolts than it would be distributed if the plates are curved.

The different chapters of the book are on the following subjects: The Locomotive Boiler; Front End, or Smoke-Arch; Steam Cylinders and Connections; Locomotive Frames, Driving-Boxes, and Spring Rigging; Rods and Connections; Breaking of Rods; Valve Motion; Valve Setting; The Compound Locomotive; Indicator Cards; Descriptions of Various Systems of Compound Locomotives; Injectors, Safety-Valves, Steam Gauges, etc.; Brakes, Air-Pumps, Valves, Pump Governors, and Westinghouse Brakes.

The general plan of the book is to give a brief description of the part treated of in each chapter, and then give a series of questions and answers by which the construction, operation, and management of these parts are described. The descriptions have more of the character which an engineer or fireman who seeks information about the running of engines would demand than elucidations of the principles or methods of construction of locomotives. The descriptions are very good of their kind, and are full of suggestions—some of them novel—which will be of very great assistance to those who have or expect to have the care of locomotives.

A considerable portion of the book is devoted to compound locomotives, and the principles and details of construction of the chief types which have been built in this country are described. The author has also given directions for the management and running of compound locomotives and hints of various kinds, telling what should be done in cases of accident with such engines, which will no doubt be read and studied with great interest, not only by engineers and firemen, but by master mechanics as well.

The typography and about half the engravings are very good. The questions and answers would, however, be pleasanter to read, and easier understood, if they were respectively printed in different type. As they are now, it is not always

clear whether one is reading the question or the reply to it. A considerable number of the engravings are poor "process" copies of good original illustrations. Many of the illustrations in the chapter on brakes are of this kind, and are execrable; and as they represent complicated structures, will be incomprehensible to most readers. The engraving on p. 109 of the combined cylinder-cock and starting-valve for Vauclain compound engine is made from a very bad free-hand drawing, and looks as though it represented the entrails of some extinct animal.

Notwithstanding these defects, the book can be recommended to the class of readers for whom it was intended. There is an incisive style about it which impresses the lessons taught, and sometimes makes things clear which perhaps would be less apparent if described more elaborately. The author says in his preface that he "has illustrated the principal 'break-downs' that happen to a locomotive, so that when one actually occurs on the road the engineer can compare the break with the illustrations in the book, and find out exactly what should be done." This statement gives the key-note to the book.

TRADE CATALOGUES.

HORIZONTAL WATER-WHEEL. Built by the Swain Turbine & Manufacturing Company, Lowell, Mass. This Company has issued a sheet giving an excellent engraving of one of their water-wheels, with a statement of its advantages, a table giving the diameter of wheels, amount of water used, revolutions per minute, and H.P. of wheels with from 6 ft. to 50 ft. fall. A list of parties using these wheels is also given.

DESCRIPTIVE CIRCULAR AND PRICE-LIST OF CENTRIFUGAL PUMPING MACHINERY. 8 pp., 6 × 8¼ in. Morris Machine Works, Baldwinsville, N. Y. This publication is what its name implies, a descriptive circular and price-list, which is illustrated by good engravings of various kinds of centrifugal pumps, but which have not had justice done to them in the printing. Some details of the pumps are also illustrated.

THE AMERICAN FUEL ECONOMIZER, *for Heating and Purifying Feed-Water for Steam Boilers by Utilizing the Heat in the Flue Gases.* The American Fuel Economizer & Engineering Company, No. 136 Liberty Street, New York. 38 pp., 8 × 11½ in.

This is a beautifully printed pamphlet, with excellent paper, typography and engravings, but is one of the most provokingly incomprehensible publications that has come to hand recently.

GLOBE SPECIAL CASTINGS FOR WATER-WORKS. Builders' Iron Foundry, Providence, R. I. 48 pp., 3½ × 5½ in. This is a new edition of a catalogue which was noticed some months ago in these columns. It includes "globe-specials, reducers, crosses, curved pipe, bends, elbows, split sleeves, offsets, plugs, caps, gate-boxes, strainers, flange, and straight cast-iron pipe." The latter part of the book contains a somewhat more extended notice of the Venturi meter than was given in the previous edition of this publication. A table giving the thickness of metal and weight per length of cast-iron pipe adds to its usefulness.

ILLUSTRATED CATALOGUE OF LATHES AND OTHER MACHINE TOOLS. Manufactured by F. E. Reed & Co., Worcester, Mass. 47 pp., 6 × 9 in.

This catalogue is made in accordance with the dimensions recommended by the Society of Mechanical Engineers for a standard size, and is one of the earliest examples of conformity to that recommendation.

The lathes illustrated are mostly of the lighter varieties, which are well illustrated with excellent wood-cuts and described in considerable detail. The largest lathe illustrated is one of 30-in. swing and bed 12 ft. long, the smallest 9-in. swing and 3½ ft. bed. A number of sizes, from 16-in. to 30-in. swing turret head-lathes, are also illustrated and described. A variety of appliances for use in connection with the different lathes is also shown. On the last page No. 1 and No. 2 milling machines are illustrated.

The catalogue is well printed and has a paper cover, which is mounted on cloth—an excellent provision to prevent its destruction.

THE CHARTER GAS-ENGINE. Manufactured by the Charter Gas-Engine Company, Sterling, Ill. 32 pp., 5 × 7¾ in. This pamphlet gives chiefly letters of recommendation from users of this engine. The latter part of the book contains an imperfect description of the engine, but it is without any illustrations, and is incomprehensible to persons who are ignorant of the principles and construction of such machines. The usefulness of the publication would be immensely increased if the publishers would give a lucid description, with suitable sectional engravings, describing the principles, construction, and operation of their engine. An excellent engraving showing an external perspective view of one of these engines is given on the outside cover, but it does not show to advantage, as the cover is a dark red color.

HINCKLEY AUTOMATIC BRAKE-SLACK ADJUSTER, *for Automatically taking up the Slack in Brake-Rigging due to Wear of Brake-Shoes and Pins, Stretch of Rods, etc.* 6 × 11½ in., 26 pp. The Hinckley Brake Company, Trenton, N. J.

This pamphlet describes the various appliances made by this Company for taking up the slack of brake-shoes and levers. These appliances are illustrated by very good engravings, most of them made from outline drawings, which show the construction clearly. A folded plate at the end of the book shows graphically the operation of these adjusters. The Company also send some sheets with directions for applying the adjusters to different kinds of brake apparatus. It is thought that it would be an advantage if the Company would describe more fully the elementary principles and the construction of their devices in their catalogues. It should be remembered by those who publish such literature that most of those who receive it are absolutely ignorant of the object and purpose of the appliances described, and do not know how it is constructed or the principles of its operation. The "wayfaring men" should always be kept in mind in writing such descriptive catalogues, and it should also be remembered that many of them are closely akin to fools in the characteristic that they are ignorant of the subject described.

GRAPHITE AS A LUBRICANT, *Scientifically and Practically Considered; also its Value as an Accessory for Engineers and Machinists.* Joseph Dixon Crucible Company, Jersey City, N. J. 16 pp., 5⅝ × 7 in. This little pamphlet contains accounts of various experiments and uses to which graphite has been put for lubricating purposes, with testimonials from various practical and impractical engineers. On the first page of the book is the following paragraph, to which we and probably some of our readers would like to add an interrogation mark. The paragraph referred to is the following:

"The difference between a perfectly pure graphite and one almost pure, but still totally unfit for lubricating, cannot be detected by either sight or touch; the buyer's only guarantee of the purity is the name and reputation of a responsible manufacturer."

Now what we would like to know, and probably some of the readers of this pamphlet will be disposed to join us in our "quest," is how do the manufacturers know whether the graphite "is perfectly pure"? If you can't see nor feel whether it is pure, how can it be known that it is pure? In other words, the buyers and users of graphite would like to know how it can be tested to know whether it is pure or not.

The latter part of the pamphlet contains observations on the nature, peculiarities, lubricating qualities, and description of the uses of graphite as a lubricator.

CATALOGUE OF TESTING MACHINES, Manufactured by Tinius Olsen & Co., Philadelphia, Pa. 42 pp., 10½ × 8½ in.

We have called attention a number of times in these pages to the fact that on many subjects trade catalogues supply the best literature that is obtainable. The publication before us is an example of that kind. The reader who has a general and perhaps vague idea of the design, construction and use of testing machines and takes up the catalogue of Messrs. Olsen & Co. will probably be surprised to find how much the subject to which it relates has been developed beyond his knowledge of it. No less than 39 different machines and instruments for testing various kinds of materials are illustrated by engravings, each of which represents only one of a class, of which there are usually a number of sizes, with different dimensions and capacities. Thus the engraving of the first machine illustrated represents six different machines of 50,000, 100,000, 150,000, 200,000, 300,000, and 400,000 lbs. capacity. The others represent from one to half a dozen different sizes of machines, so that somewhere about 200 different machines and

instruments are described in the catalogue, and are made by this firm. The extent to which such machines are now used will also be a surprise to many readers. On p. 4 is a list of firms and companies which are supplied with the Olsen machines. This includes one of 400,000 lbs. capacity, furnished to the Johnson Company, of Johnstown, Pa., two of 300,000 lbs. capacity, 15 of 200,000 lbs., 34 of 100,000 lbs., 20 of 50,000 lbs., eight of 40,000 lbs., four of 30,000 lbs., two of 20,000 lbs., and 14 of 15,000 lbs., or 100 machines which are now in constant use in the works and laboratories of various manufacturing establishments and educational institutions. This includes only one class of machines. Other lists of other kinds in use include the names of no less than 102 different firms, companies and institutions, which have been supplied with appliances of this kind by this firm, showing how very general the practice now is of making systematic and scientific tests of materials used in various kinds of structures and supplied for different purposes.

The catalogue includes not only machines for determining tensile and compressive strength of metals and other materials, but special machines for testing wire band iron and springs, for subjecting materials to impact, transverse and torsional strains for testing chains, bridge building material, cement, textile materials, yarn, thread and oil. The catalogue gives an excellent idea of the various uses in which testing machines are now employed, and the extent to which they are used. The engravings, with the exception of the first one, which represents this firm's exhibit in the Columbian Exhibition, are all excellent wood-engravings. The one referred to is hardly up to the standard of the rest.

The latter part of the book contains some folded plates, one of them showing a new machine, for structural material, having a capacity of 200,000, 300,000, or 400,000 lbs. Another folded sheet gives engravings and a description of a new automatic and autographic machine. The last plate is an outline engraving of one of these machines, with a full description of it. There are also directions for operating testing machines. The usefulness of the book would be increased if a short elementary treatise was given on the construction of testing machines, and if the methods and object of such tests was described, so that a novice could go to it for information.

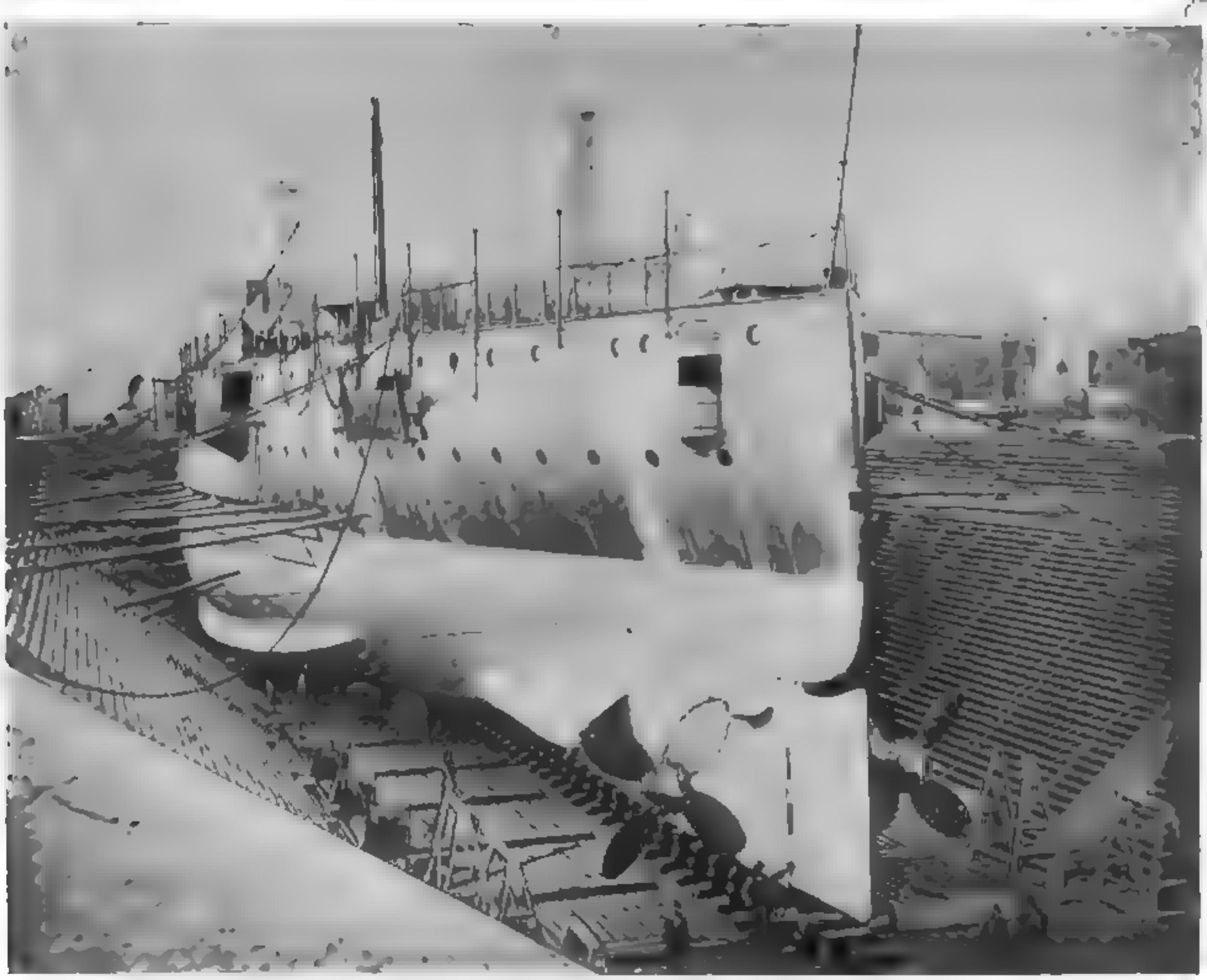
THE LAST OF THE LOCOMOTIVE PROBLEM.

Editor of The American Engineer:

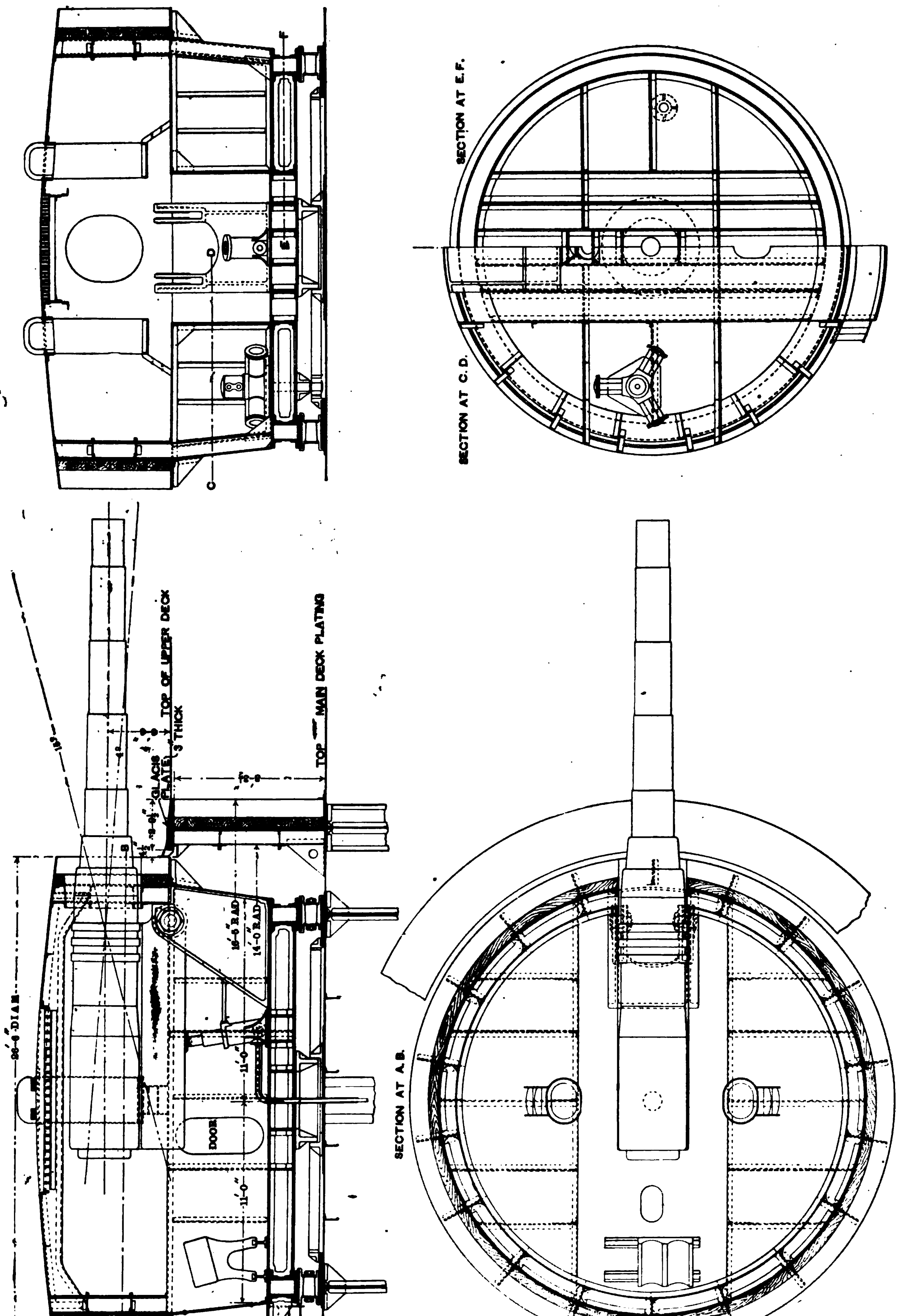
Although you announced in the February issue that your columns would be closed thereafter to contributions on the "Locomotive Problem," I hope you will allow me the space to point out that although M. René de Saussure, in that number, acknowledges his error in saying that the position of maximum piston velocity was when the crank and connecting-rod were at right angles, and gives the geometrical conditions which are to be satisfied, he has not given the slightest information as to the geometrical construction necessary to determine the position of the cross-head at the moment of maximum velocity.

We simply know that at that point, wherever it may be, a triangle having the connecting-rod for one of its sides, and its opposite angle somewhere on a vertical through the center of the cross-head pin (which is, of course, unlocated), forms a right angle at that angle which is at the center of the crank-pin at the required instant.

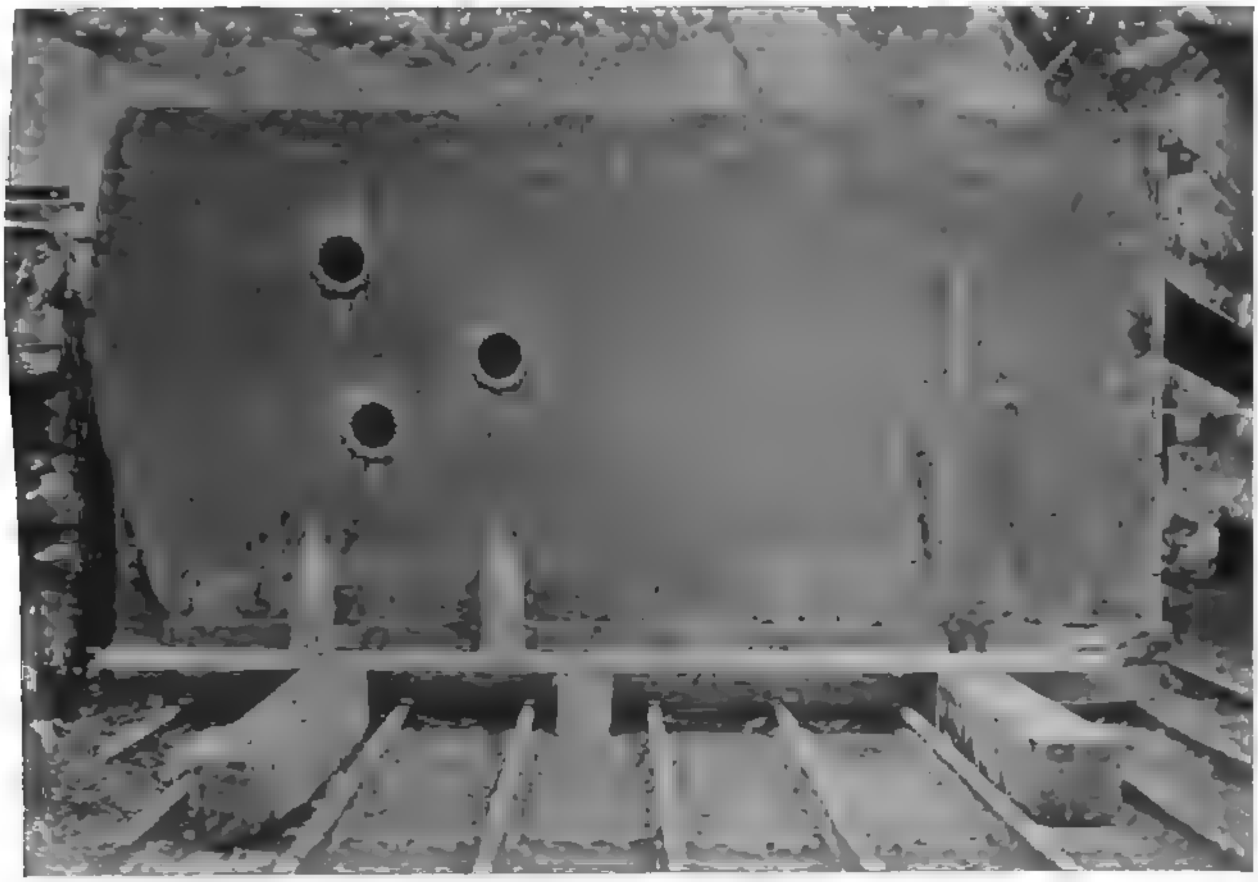
So far from being a solution of the question, this is no more than the equation of condition which results when Mr. Linden-



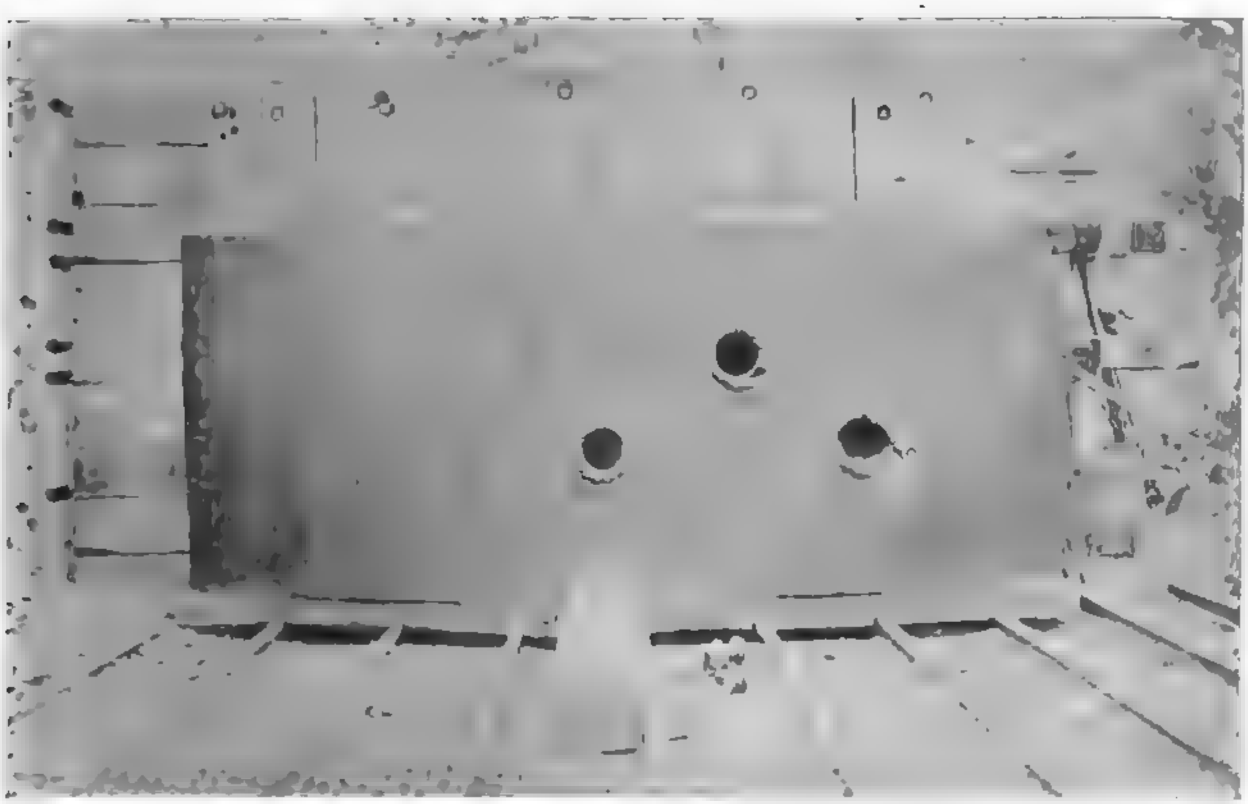
UNITED STATES BATTLESHIP "TEXAS" IN DRY DOCK AT NORFOLK, VA., NAVY YARD.



TURRET OF UNITED STATES BATTLESHIP "TEXAS."



TEST PLATE OF REDOUBT ARMOR UNITED STATES BATTLESHIP "TEXAS."



TEST PLATE OF TURRET ARMOR UNITED STATES BATTLESHIP "TEXAS."

berger puts his second differential coefficient equal to zero; and is considerably harder to solve, since there are known methods of solving all cubic equations, I believe, while this problem requires a special solution to be worked up for this individual case, which is by no means an easy matter.

It is possible, I know, for I saw some years ago in the London *Engineering* a geometrical solution which, I think, was said to have originated with Professor Rankine, but my recollection is that it was quite long and difficult, so that by the time the result is reached the balance of simplicity is on the side of the analytical method; while the geometrical method has the further disadvantage that, on a sheet of paper of any reasonable dimensions, the desired angle could not be obtained to less than two or three minutes of arc, and the cross-head position not located to more than two places of decimals in inches. I believe that this problem has no practically useful application, and therefore when we want a solution of it we want one which is satisfactorily accurate, as Mr. Lindenberger's is. This being the case, with all due respect for M. de Saussure's geometrical solution, as far as it goes, one cannot help being reminded of that famous colt which only had two defects: the first was he was hard to catch, and the second was that after he was caught, he wasn't worth a —— anything.

J. ERSKY JOHNSON, JR., M.E.

SYRACUSE, N. Y.

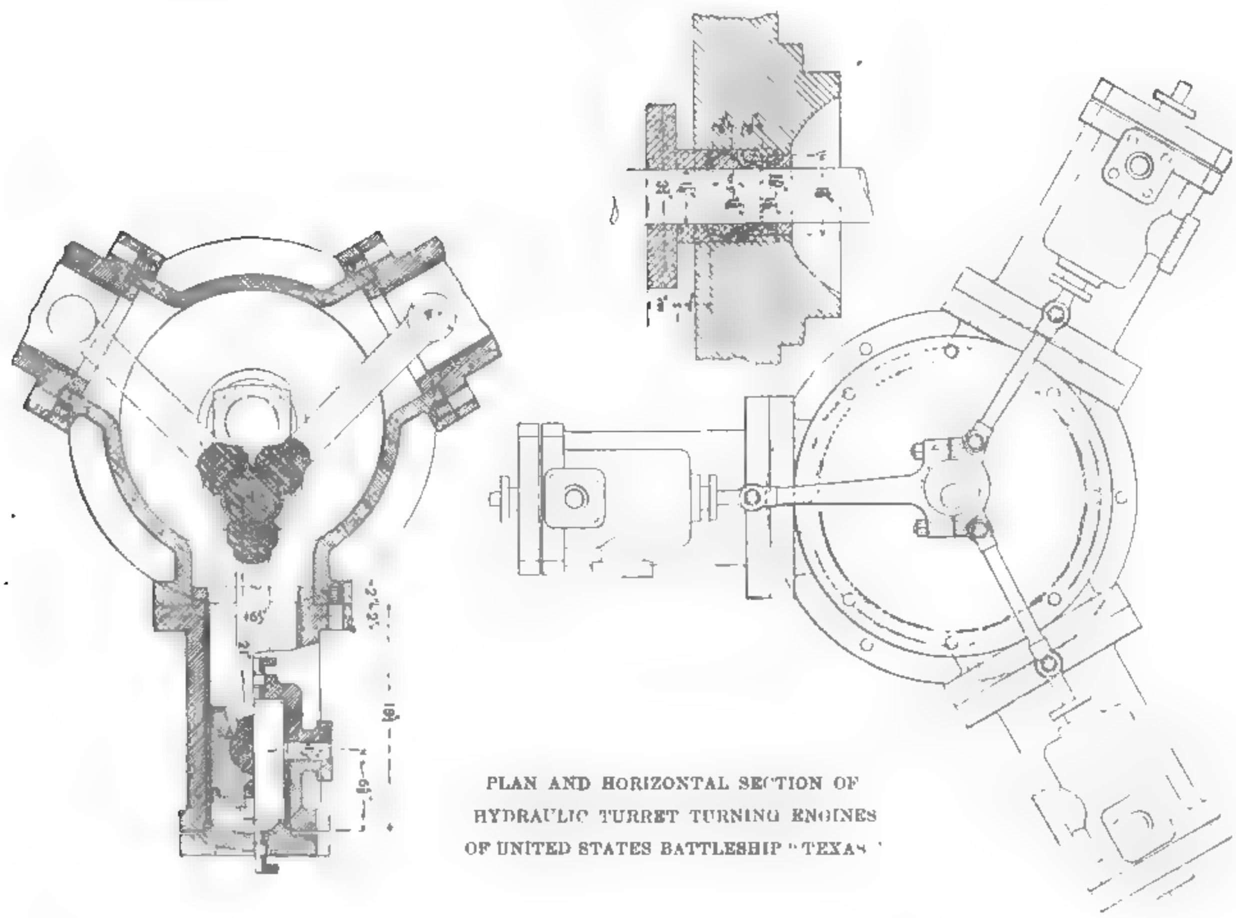
TURRET AND TURRET-MOVING MACHINERY OF THE UNITED STATES BATTLESHIP "TEXAS."

IN our last issue we published a general description of the United States battleship *Texas*, accompanied by illustrations of the vessel itself. Through the courtesy of the officials of the Navy Department and the contractors for the parts furnished, we are now enabled to give a very complete set of illustrations, showing the method of construction adopted in the building of the turrets and the mechanism employed in their operation. A reference to the deck plan of the ship, published in the March issue, shows that the turrets are located *en échelon* with the forward turret on the port side, and that the two are embraced within a redoubt armor that extends diagonally across the vessel protecting the machinery.

The armor for the ship is all of nickel steel not Harveyized, and has been manufactured by the Bethlehem Iron Company, of South Bethlehem, Pa. The half-tone photo-engraving of this armor, with the three shot-holes in each plate, is a reproduction of a photograph taken of the test plate selected for the ballistic trial for acceptance. It may be remarked that in the selection of the trial plate the Government representative and inspector invariably selects what appears to him to be the poorest of the

TEST OF REDOUBT ARMOR.

Shot No.	Gun Used.	Projectiles. Kind.	Projectiles. Weight.	Striking Velocity. Ft. per Second.	Energy in Foot Tons.	Penetration.	Remarks.
1	8-in. Breech-Loading Rifle............	Holtzer	250 lbs.	1,678	4,885.7	14 in.	No Cracks.
2	" " "	"	250 "	2,006	6,982.4	Perforated.	" "
3	" " "	"	250 "	1,835	5,842.8	15½ in.	" "
Total.	....	... .	... ..	......	17,710.9	......	......



PLAN AND HORIZONTAL SECTION OF HYDRAULIC TURRET TURNING ENGINES OF UNITED STATES BATTLESHIP "TEXAS."

lot that has been offered for acceptance. It was of nickel steel, measuring 16 ft. 6 in. by 8 ft. 4 in., with a thickness of 12 in. and weighing 69,128 lbs. The test was made at the proving grounds of the Bethlehem Iron Company, at Redington, Pa., on March 22, 1893, with the results given in the table on the previous page.

The test resulted in the acceptance of the group of plates, and is noticeable for the entire absence of cracking.

Referring now to the full-page engraving of the turret, the construction is at once apparent. The redoubt armor extends from the top of the main deck plating for a height of 8 ft. 3½ in. to the top of the upper deck. Its sides are parallel to each other, and it has a uniform thickness of 12 in., with a backing of wood 6 in. thick. The wood is in turn held by a heavy plate framing strengthened by horizontal plates kept in position by angle irons. The whole is capped by a glacis plate 3 in. thick, and so tapered off on the outer edge that in case it is struck by a shot, the latter will glance and strike the armor of the turret. The turrets are 26 ft. 6 in. outside diameter, and the armor plates are bent at Bethlehem to conform thereto. The photo-engraving of the test plate of the turret armor gives a good idea of its general appearance after the trial. Like that of the redoubt armor already referred to, this plate secured the acceptance of the turret plates. It is a nickel steel plate measuring 15 ft. 7 in. × 6 ft. 2 in. with a thickness of 12 in and weighing 48,400 lbs. It was tested at the Redington proving grounds of the Bethlehem Iron Company on May 31, 1893, with the results given in the accompanying table:

and toughness resulting from forging, and because any slight unevenness on the back side can be taken care of by bedding the plate into its wooden backing, to which it is drawn by holding bolts.

The preliminary machining consists in trimming the plates on their longer edges to somewhat full of their finished width, and in beveling or rounding the edges if required. This work is done with cold saws, planers and milling machines. The metal is left on ends of plates for further testing. After the first machining the plates are sent to the 7,000-ton bending press to be bent or curved as per templates; they are then ready for tempering.

The operation of tempering requires a powerful crane, large heating furnaces and a great tank of oil. Its object is to toughen the steel and give to it the proper hardness, and it calls for much experience and skill.

After tempering further test specimens are cut from the ends of the plates in order to determine the physical qualities resulting from the treatment. If the qualities are satisfactory, the plates are ready for the ballistic test, and a plate for this purpose is chosen from the lot or group by the Naval Inspector. If the ballistic test is successful, the lot or group which it represents is ready for finishing.

The finishing consists in "rectifying"—that is, slightly bending at the press to bring the plates as nearly as possible to the shape of the templates, and in accurately machining all the edges to required dimensions.

The last operation is the drilling and tapping of the bolt-holes in back of plates, for the bolts which hold the plates in

BALLISTIC TEST OF TURRET ARMOR UNITED STATES BATTLESHIP "TEXAS."

Shot No.	Gun Used.	Projectiles.		Striking Velocity. Feet per Second.	Energy. Foot Tons.	Penetration.	Remarks.
		Kind.	Weight.				
1	8-in Breech-Loading Rifle............	Holtzer	250 lbs.	1,576	4,304.4	11⅛ in.	No Cracks.
2	" " "	"	250 "	1,826	5,776.8	15 "	" "
3	" " "	"	250 "	2,004	6,958.8	Perforated.	" "
Total	....	... .	....	....	17,041.0	... .	....

The remarkable results obtained are such that the manufacturers are to be congratulated upon the high grade of the plates turned out. It will be interesting here to call attention to the methods pursued at South Bethlehem in the making of these exceedingly heavy plates. In the first place, all of the machinery and the whole plant employed had to be designed and constructed from the very foundations, and this will form a lasting monument to the memory of Mr. John Fritz as the last notable engineering feat of his career. The specifications of the Navy Department require that the ingot shall weigh at least twice as much as the finished plate, in order that perfectly sound and solid metal may be secured, and all pipings be cut off in the ample shrink head that has been allowed. The steel is melted in open-hearth furnaces, and drawn out into ladles having capacities of from 40,000 to 90,000 lbs. each. These ladles are mounted upon trucks that travel over rails laid along each side of the casting pit. The ingot molds are set up in this pit, and in casting the larger ingots, the contents of several ladles, each consisting of the charge of one furnace, are poured into one mold. Thus an ingot weighing 110 tons can readily be cast. After an ingot has been allowed to cool in its mold for several days it is taken, while still hot, to the great 125-ton hammer or 14,000-ton press and forged down to the proper thickness, that portion of the ingot which was cast at the bottom forming the body of the plate.

In the case of plates tapering in section, the taper is usually formed in forging. The faces of the plates are completed in this operation—that is, they are not as a rule subsequently machined, but are used black as they leave the hammer or press, except that some of the scale is removed by chipping. When the plate is forged to the required thickness, and somewhat full of width, a large amount of metal from the top of the ingot and a small amount from the bottom is cut off at the hammer or press. The plates are then annealed. After annealing, test specimens are taken from each end of plates to determine the physical qualities of the steel in its natural or annealed condition, and chemical analyses are made. If tests are satisfactory, the plates are then ready for preliminary machining.

As already stated, the flat faces are, as a rule, not machined. It is unnecessary, because the front side, which is exposed to the impact of the shot, should possess all the surface hardness

position on the ship. These bolts vary in diameter from 1.5 in. to 3 6 in., according to the thickness of the plate, and are spaced about 2 ft. apart each way, or one every 4 ft. of surface. From the above description, it will be seen that the whole manufacture is one requiring great care and a thorough knowledge of conditions both chemical and physical at every step, and the wonderful results of the ballastic tests already referred to, where several 8-in. shots striking with an energy of nearly 7,000 foot-tons fail to develop any cracks, indicate to what perfection the production of this material has been brought.

Returning now to the engraving of the turret after this digression, we find that it is protected by 12-in. armor backed by 6 in. of wood and covered with a 1½ in. plate. The armament of each turret consists of one 12-in. breech-loading rifle, which is given the proper elevation for firing by the hydraulic lift shown in the vertical section of the turret at the upper left-hand corner of the engraving.

That portion of the turret which comes back of the redoubt armor is constructed of shape irons and has the form of an inverted truncated cone. Starting in with a diameter of 24 ft. 6 in. just back of the wooden backing of the armor, it tapers down to a diameter of 22 ft. at the floor-line. The main floor framing of the turret is formed of what may be termed a circular box girder built up of 1½ in. plates and heavy angles with a depth of 19½ in. This framework is carried on a wooden lining, which in turn rests in a cast ring that is carried directly on the conical rollers 7 in. in diameter. The rollers run on a circular casting that is carried on wood bolted to the upper plating of the main deck.

Each turret is provided with two small conning-towers located on either side of the gun, and provided with suitable arrangements for handling the turret and the gun, with indices denoting the positions of both. As we have already said, the work of moving the turret, training the gun, and hoisting the ammunition is all done by hydraulic machinery. For this purpose there is a hydraulic plant for each turret, each consisting of two independent pumps built by W. T. Davidson, and to which we will again refer. The specifications required that the combined capacity of the pumps for each turret should be 400 galls. per minute at a pressure of 1,000 lbs. per square inch.

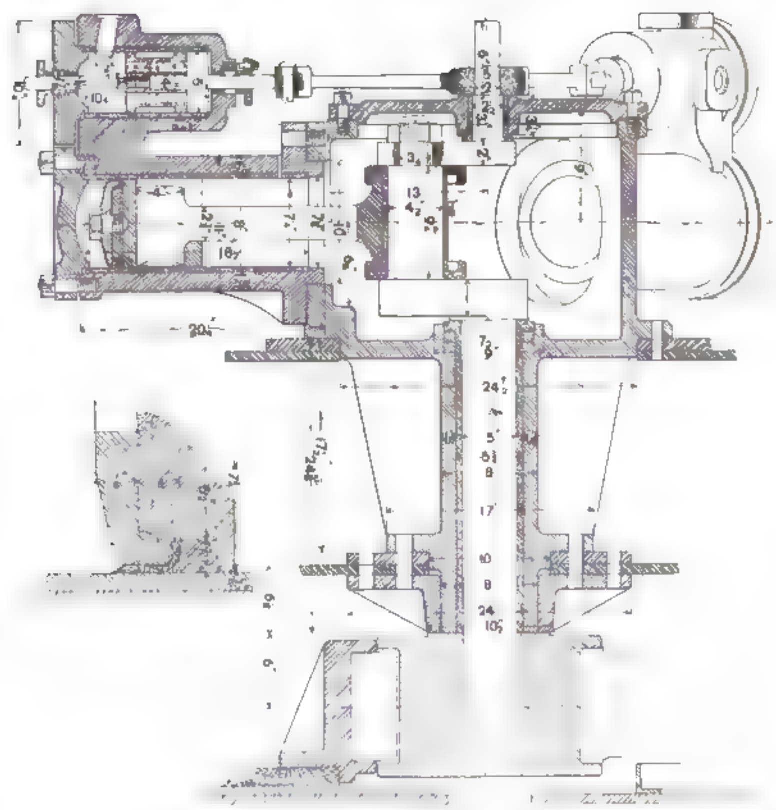
There are two gears for revolving each turret meshing in with a rack bolted to the main deck. The rack is made of cast steel with shrouded teeth and in sections. The pinions are of composition, with a diameter of 18½ in. on their pitch circles and a face of 8½ in. Ample provision is made for oiling the pinions and racks, and a brass drip-pan is placed inside the rack and extending beneath the pinion in all of its positions. The pinions are keyed directly to the lower end of the main shaft of the turning engines. When the contract for the machinery of the *Texas* was taken by the Richmond Locomotive Works, there were no hydraulic engines manufactured in this country that were at all suitable for the work proposed. The requirement was that each engine should have sufficient power to turn the turret at the rate of one revolution per minute, with the gun run out and the ship on an even keel, while the two together are capable of doing the same work when the vessel is heeled 10°. With this problem in view, the hydraulic engines which we illustrate were designed by Mr. C. J. Mellen, Chief Draftsman of the Richmond Locomotive Works.

Before entering into the details of the engines, it will be well to pass in brief review some of the arrangements of the piping, valves, etc., in connection with them. There are stop-valves in both the pressure and exhaust-pipes, so that either engine can be shut off in case of accident. In each sighting station or conning-tower there is a hand-lever for controlling the movement of the turret, which moves the valve of a supplemental hydraulic cylinder through a floating lever, so that the piston follows the motion of the hand-lever, while the piston of this cylinder works through a system of levers and operates the reversing valve of the turret engines. The reversing valve is also so connected to a floating lever that when the turret has revolved to a prescribed limit it (the reversing valve) is automatically closed. The attachment is also so made that in case of such leakage of the valves as to allow the turret to run beyond the limits prescribed, the engines will be reversed. The hand-levers in the turrets are provided with locomotive latches and quadrants. Relief valves are so fitted and adjusted that, when the water is shut off or the engines reversed, the momentum of the turret is gradually overcome by the action of these valves.

Each turret is also provided with an hydraulic locking device, consisting of a cylinder, plunger, and locking bolt with the necessary valve gear. The end of the bolt is tapered to facilitate entering the locking slots, of which there are two, one for each loading position. There is also an interlocking device to prevent the bolts being shot while pressure is upon the turning engines, as well as to prevent the latter being put in motion until the locking bolts are withdrawn.

For a further facilitation of the work there is an index in each turret in plain view of the man stationed at the locking-bolt lever, and an electric bell in each sighting station, which is so arranged as to give warning of the approach to either loading position.

Reverting now to the details of the turret-turning machinery, we would call especial attention to the simple manner in which all of the details have been worked out. As we have said, the engines were designed at the Richmond Locomotive Works for this particular place, and are of the three-cylinder, single-acting type with cylinders set at intervals of 120°. They lie in a horizontal plane and work upon a vertical shaft carrying a pinion at its lower end. The cylinders have a diameter of 7½ in. and are lined with a composition bushing ⅜ in. thick. The stroke is 12 in. The piston packing is of U section, though it is so held by the follower (see sectional view) that it is converted into a cup packing. The rod is connected to the piston by a T head and oscillating bearing without any take-up. The ends of the rods bear directly against the bushing of crank-pin, and are held in position by return rings on the bushing and washer, as shown in the section. The valves are plain piston-valves of the D type, and are all driven by the same eccentric. The working diameter of the valve-chest is 5 in., and it is lined with a composition bushing $\frac{7}{16}$ in. thick. The valves are of composition with no packing, while the valve-stem is packed with a stuffing-box and gland. The engine, in order to turn the turret in the time specified, must make about 11 revolutions per minute. They are reversed by a special valve shown in half-section and elevation, which converts the exhaust passage of one motion to the inlet passage of the other. The construction will be readily understood from the engraving. The inlet is at the left of the portion shown in section. An examination of the drawing shows that the openings above and below the inlet are closed by a packed valve seated on the metal of the casing. These two valves move in opposite directions, and the opening of one tends to hold the other still more firmly upon its seat by the extension of the spring shown in the side elevation. The combination of levers is such that as one valve rises it lifts its lever, and the spring connecting the two, causes the other to hold its valve down against its seat. The operating lever at the top of the engraving is also so arranged that, as the inlet-valve is raised, the corresponding exhaust-valve in the second casing is lowered. The supply water then enters the passage and, if the lower inlet-valve is opened, passes out through the lower flanged opening to the engines, doing its work and returning to the reversing valve by way of the upper flanged opening. The upper valve of the exhaust casing being open, the exhaust water flows down through it to a central cavity and escapes by a similar flanged opening in the right hand casing (not shown), to that by which it entered at the left.



SECTION OF TURRET-TURNING ENGINE.

If the engines are to be reversed, the upper left-hand valve is opened and the upper central flanged opening to the engines becomes the supply and the lower the exhaust, thus causing the desired reversal of the motion.

Cup packing is used throughout this valve, and composition metal is used for all of the moving parts.

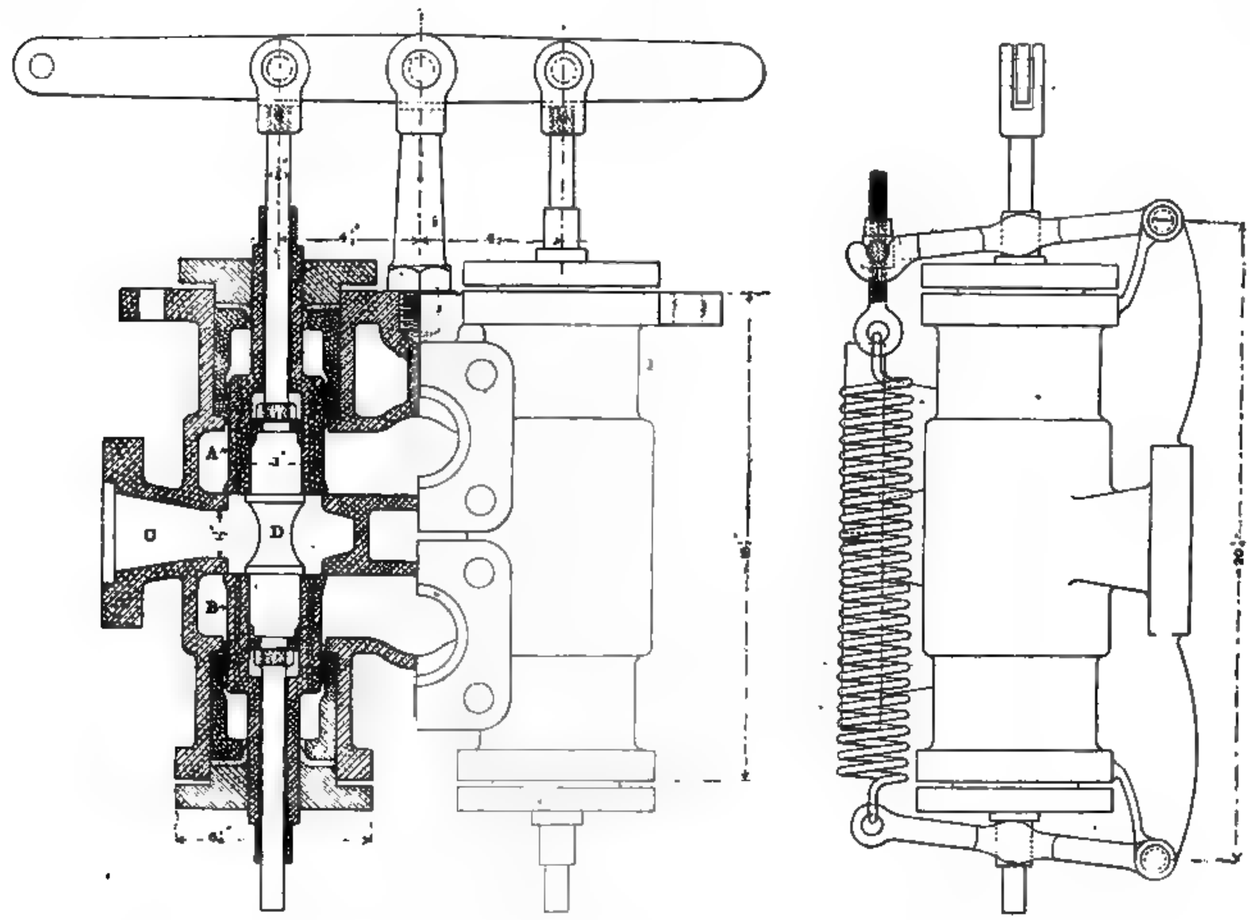
After the exhaust has passed the reversing valve it is led directly to the center of the turret and into the pivot pipe. This consists of a stand located in the center and receiving the pressure pipe, as indicated on the engraving. The supply water is led up through a central pipe to a point near its upper extremity, whence it goes to the reversing valve, returning from which it enters an annular space and comes down and out at the discharge pipe, as shown. The flanged connections for leading off the supply and receiving the exhaust are on a separate casting that turns about the central supply pipe with the turret. This casting is packed above and below the flanges with cup packings, and is held down in place by the flange held to the top of the supply pipe by the stud and nut, as shown.

The specifications required that there should be an automatic pressure regulator with an adjustable relief valve, and so arranged as to stop and start the pumps when required without allowing the water pressure to fall below 950 lbs.

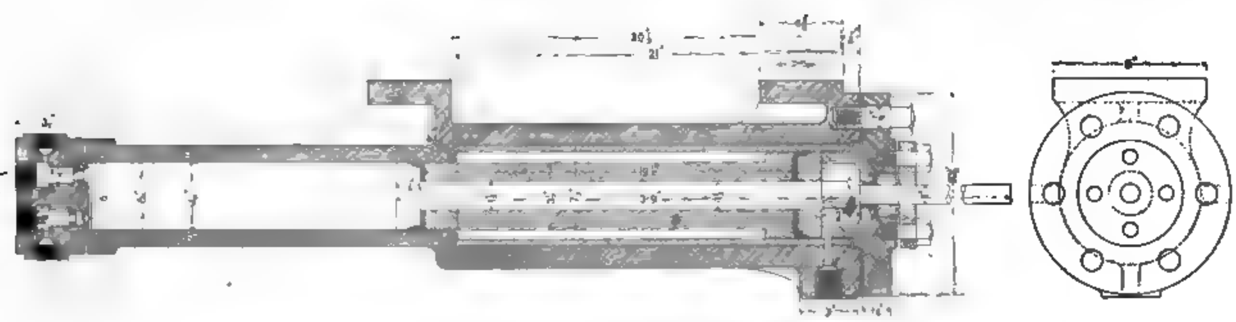
pressure. In order to meet this requirement the pressure regulator, which we illustrate, was designed by Mr. Mellen.

It consists of a cylinder of composition metal in which a piston packed with leather has a free motion, being protected from striking too severe a blow against either head by the rubber packing shown. Water pressure is admitted at the rod end through the 2½ in. opening, and compressed air comes in at the other. As the water pressure rises it forces the piston against the air, and the rod shuts off the pumps through suitable connections. As water is drawn from the supply pipes, the air forces the piston back and starts the pumps. The back end of this regulator is connected with an air compressor that maintains a constant pressure in this cylinder and an expansion tank or air vessel.

air must be compressed in two stages, first by an air pump actuated by steam, and second by an air compressor actuated by the water pressure directly from the main pressure pipes. As the air enters from the air pump it forces the ram *down* until it reaches the bottom end of the stroke, where it remains until it is required to have the pressure or the volume of air increased in the air vessel, when, by a simple movement of the lever operating the valves shown in fig. 1, the horizontal valve is opened and the water pressure let in to act on the larger piston, when the air in front of the smaller piston is forced into the air vessel. When the plunger reaches the upper and the motion of the lever is reversed, then the water from below the piston exhausts to the tank, and the operation is repeated when required. As no air is used except that of leakage, an automatic operation of this compressor is not considered necessary, although such an arrangement could easily be attached. Should the air pressure in the air vessel fall below a certain point, there is a tell-tale leak hole in the piston to call attention to the fact.



REVERSING VALVE FOR TURRET ENGINE UNITED STATES BATTLESHIP "TEXAS."



AIR COMPRESSOR UNITED STATES BATTLESHIP "TEXAS."

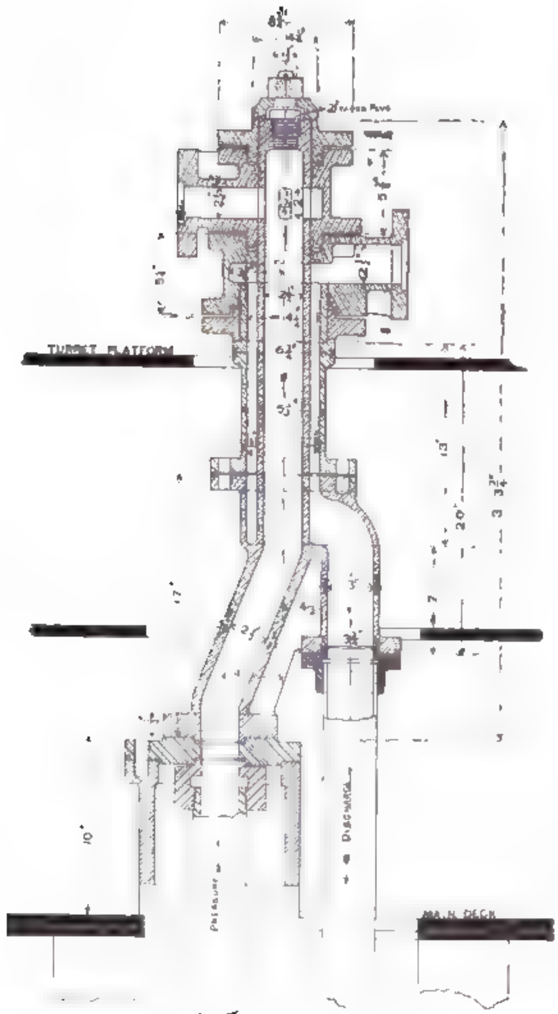
This compressor consists essentially of a cylinder having two diameters and in which a long plunger moves to and fro freely. A sectional view of the head of the small end of the cylinder shows it to be provided with two valves held to their seats by springs.

Due to the high pressure of 1,000 lbs. to the square inch, the

We now come to the hydraulic pumps supplying the pres-

sure for the machinery just described. They were built by M. T. Davidson, of Brooklyn, N. Y., are four in number, each being double-plunger pumps. They are arranged to work in pairs, one pair for each turret. The engraving gives an idea of their general external appearance. Owing to the limited space available and the peculiar service demanded of them, these pumps were especially designed for the place. The steam cylinders are 24 in. in diameter with a stroke of 24 in., and the water cylinders are made with a diameter of $6\frac{1}{4}$ in. The steam pressure is 100 lbs. to the square inch, and the water pressure to be developed is 1,000 lbs., in accordance with the specifications as already mentioned; the maximum speed being 100 ft. of piston speed per minute.

The steam ends of the cylinders are of the regular Davidson type, and are fitted with metallic packing in the stuffing-boxes. The main valve is a piston valve operated by a rocking valve driven directly from the main piston-rod.



PIVOT PIPE FOR THE TURRET OF THE "TEXAS."

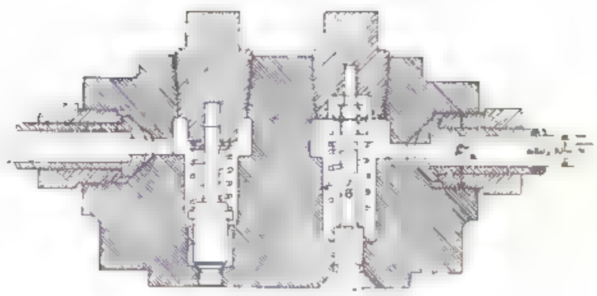
Owing to the difficulty that has been experienced in heavy-pressure pumps of strengthening the flat valve surfaces, each water valve in this pump has a separate cylindrical pocket or chamber and each two contiguous valves have their own independent outlet to the manifold, no valve plate being used at all. The valves and valve seats are of phosphor bronze, the valves having a lift of $\frac{1}{4}$ in. They are very easy of access, and any valve may be removed by unscrewing the cap screwed in above it. Each pump weighs 4,500 lbs., and has a length of about 9 ft. over all; the width is 28 in. Each pair of pumps, with all fittings, tanks and attachments, occupy a space of 9 ft. 6 in. × 7 ft. 6 in., with ample room left to remove cylinder heads or doing any other necessary work of examination or repairs.

NOTES AND NEWS.

The Large Krupp gun recently exhibited at the World's Fair, Chicago, was loaded recently into the steamship *Turrett* at Sparrow's Point, Md., without incident or hitch of any kind.

A New Mississippi River Bridge.—Contracts have been signed for a new bridge over the Mississippi River at New Orleans, and the Phœnix Bridge Company, of Phœnixville, Pa., will be the builders. The structure is to be about 2 miles long, double track throughout. The approach spans vary in length from 25 to 150 ft., as the heights of the supporting towers increase. The river portion of the bridge is to be a cantilever structure with two anchor arms of 608 ft. each, and a central span of 1,070 ft.

Spanish Cars.—In the construction of passenger cars in Spain, the system followed is almost analogous to methods prevailing in the principal European car-works. The skeleton frame of the bodies is ordinarily made of selected oak and elm,



HEAD OF AIR COMPRESSOR, SHOWING VALVES.

while mahogany or teak provides for the outer roof, and receives nothing but a coat of varnish. As to the interior, the sides are fixed up with painted red-pine linings, or with fine woods, or tapestry-covered, depending on the rank of the car. It is usual to build with all iron frames, steel axles, steel-tired wheels, the wheel centers being of stamped or forged iron. These central parts are never made of cast iron nowadays. The measurements, which are more ordinarily followed in the builds of cars and trucks, are the same as the common European ones, which range from 6 to 9 m. long, with a box width of $2\frac{1}{2}$ to $3\frac{1}{4}$ m. The long passenger cars common to the United States, bogie mounted, were introduced several years ago into Spain, and are slowly but steadily coming into favor. The chief car-builders of the peninsula, Sociedad Material para Ferrocarriles, of Barcelona, are constructing a number of them.

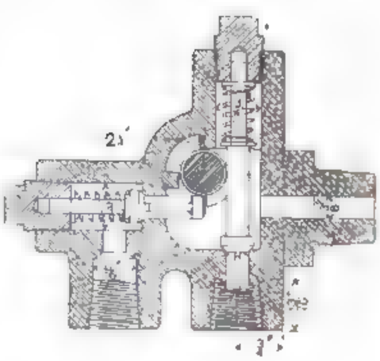


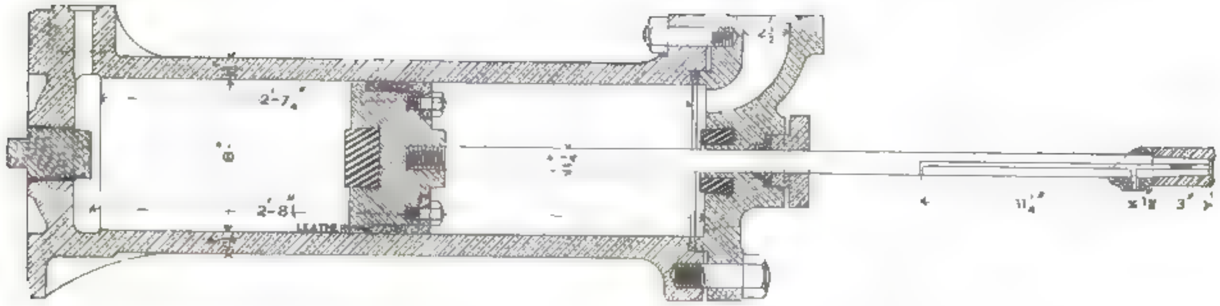
Fig. 1.

Narrow-gauge freight cars are also made on a large scale in Iberia, to a gauge of 1 m. (5 ft. 4 in.). The construction is similar to those run on the standard 5-ft. gauge. They weigh about 6,000 lbs., and are registered for carrying 14,500 lbs.—*The Indian Engineer*.

Parrots as Station Callers.—An exchange is authority for the statement that almost every station-master on a German railway has a parrot or starling so trained that whenever a train draws up to the platform it commences calling out the name of the station most distinctly; and not only this, but continues doing so while the train remains there. While we have not seen this remarkable example of saving in lung power in our travels over Germany, the scheme is certainly a simple one. How would it do to have the parrot as an auxiliary to the ordinary train-hand who naturally inquired from Mr. Depew what kind of a tenor he would expect to get for \$40 a month, when the rule was issued on the New York Central & Hudson River Railroad that all stations should be announced distinctly? The only time we have ever heard the stations announced distinctly was when we were in company with some of the upper

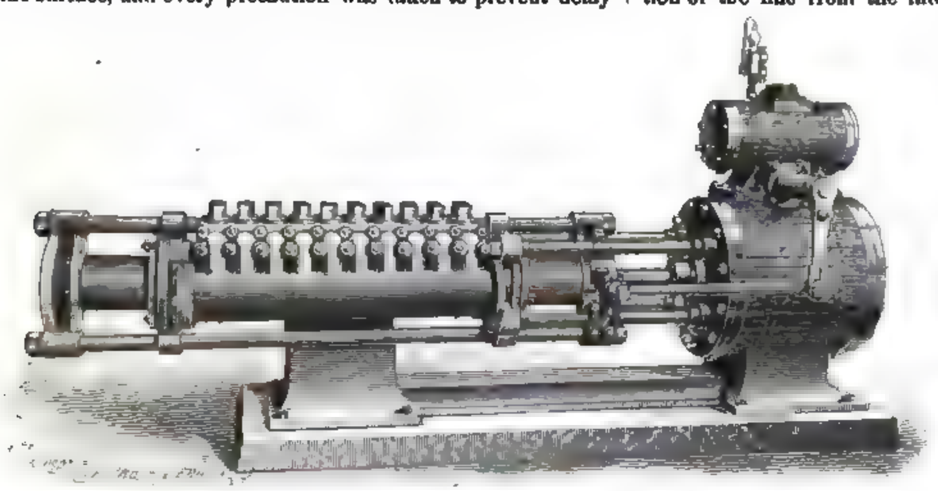
officials of a railroad; then the tenor voice of the brakeman has no difficulty in obtaining a distinct enunciation, but upon the disappearance of the official the voice at once relapses into a long howl, which is utterly unintelligible. Perhaps if each brakeman were equipped with a parrot the improvement in service would be very great.

Raising a 60-ton Engine.—The *Portland Transcript* gives the following account of the raising of a Canadian Pacific mogul engine that ran off an embankment into Harvey Lake on the night of January 13. The work was carried on under great difficulties, with the thermometer often being at 30° below zero, and with a snow blowing over the lake at times more than 50 miles an hour, causing a suspension of the work for days at a time. In preparing to raise the locomotive, weighing 60 tons, 16 holes, 3½ in. diameter and 20 in. deep, were drilled in the solid rock, and as many steel posts were planted



HYDRAULIC PRESSURE REGULATOR UNITED STATES BATTLESHIP "TEXAS."

and set in lead. These were for fastening guy lines and purchases, and the men who drilled and set the posts were kept from freezing by the aid of fires kindled upon the snow. A number of ingenious fastenings for purchase blocks were made very near the track by sinking heavy oak timbers in trenches at the ends of the ties that were tamped with gravel and wet, which after 24 hours were frozen so solid that they were quite as strong as the iron fastenings upon the bluff. Very heavy sheer poles 30 ft. in length were built and erected to overhang the embankment, and were provided with two sets of very heavy ship blocks and falls for lifting, and two of equal strength were placed in position for pulling from the bluff. As no diver was employed, everything was done from the surface, and every precaution was taken to prevent delay



HYDRAULIC PUMP UNITED STATES BATTLESHIP "TEXAS."

to trains. By the aid of a swinging mirror attached to a long pole, with light thrown upon it in the night by a dark lantern, successful fastenings were made to the engine 15 ft. under water with heavy grappling hooks. The driving-wheels were badly entangled in bowlders, rendering it next to impossible to move the monster. With three locomotives working upon independent purchases, and aided by the buoyancy of the water, it was finally drawn to the surface. At one time, while attempting to raise the engine and tender, it was found that the locomotives were exerting a force of 240 tons.

Aluminium Horse-Shoes.—Concerning his experience with horse-shoes of aluminium, M. Japy reports that as that metal is four times lighter than iron, a complete outfit of shoes of it will weigh no more than a single iron horse-shoe. Horses accustomed to iron shoes when shod with shoes of aluminium imagine themselves barefooted, and are as careful in planting their steps as if they were unshod. The shoes open out as the hoof expands, and consequently never cramp it. An aluminium horse-shoe will last from 40 to 60 days, according to the composition of the alloy and the kind of work done by the horse. M. Japy concludes that aluminium can be utilized in shoes for race and carriage horses, and that it may be of service in the treatment of diseases of the hoof. It should, however, be used only by persons experienced in working the metal.—*Popular Science Monthly.*

Wind-Power and Electricity.—Professor James Blyth, who has been experimenting in the utilization of wind-power for the generation of currents, was the first to make trial of the windmill at Marykirk, in Scotland. He first adopted the English type of windmill having four arms and canvas sails; but the sails were too easily torn during a head-wind—the very time they were most required. Next he used the American type, having a number of arms and blades of cast iron. He has now devised a new system. To four strong arms, each about 26 ft. long, he attached semi-cylindrical boxes, the opening of each box being 10 ft. by 6 ft. The vertical shaft is a long rod of iron 5 in. in diameter. At the lower end it carries a massive pit wheel, which actuates a train of gearing, and drives a fly-wheel 6 ft. in diameter. With a fair wind speed it gives 4 electrical H.P.; and it works very satisfactorily in a strong gale.—*Electricity.*

"The Indian Engineering" tells a story of the construction of the line from the interior of Manchuria to the coast, and along which it was recently proposed to make a junction with Moukden, the chief point. The engineers consulted the Tartar general, and the general, before giving his sanction, consulted the geomancers, who declared that if the line were laid along the proposed track, the vertebræ of the dragon that encircles the city would be broken by the nails of the sleepers. Such a contingency was too awful to contemplate, and the general promptly informed the engineers that the thing was impossible. The latter, in despair, lodged a protest with Li Hung Chang, who, while commending the caution of his subordinates, expressed it as his opinion that the hidden dragon would suffer no harm, rather otherwise, by the innovation. However, he would refer the matter to the Emperor. This struck terror into the heart of the general, and he again consulted the geomancers. Eventually a line was traced some hundreds of yards away from the site at first proposed.

A Universal Telescope Stand.—The construction of a good and simple universal mounting for small telescopes has been the aim of many instrument makers, and it is pleasing to note an advance in this direction made by a firm in Vienna. In their new so called "universal station" they have overcome many of the main difficulties. The chief point about this special kind of mounting is that the observer can either use the telescope as a theodolite—that is, with circles reading altitude and azimuth—or by a slight adjustment he may have the equatorial mounting where the circles read right ascension and

declination. This end is gained by hinging what would be the polar axis on to a pivot at the side of the stand, thus allowing the axis to be moved from the horizontal to the vertical or any intermediate position. A strong metallic arc fixed on the top of the stand supplies a means of clamping this axis and giving it a slight adjustment. With the axis vertical, we have then practically a theodolite mounting With the axis out of the vertical, a parallactic mounting. It is needless to say that this mounting is only for small telescopes, and indeed its application to large ones is not needed.—*Nature.*

Incandescent Gas Lighting.—Cannel coal is generally used for enriching ordinary coal gas and imparting to it the standard illuminating power. Owing, however, to the decreased yield of that mineral, the price of it has gone up excessively, so that gas engineers are casting about for a substitute. In the meantime, it has been suggested that gas of a comparatively low candle power might be supplied to the public, and its illumination raised by special methods of burning it. In this connection we may notice the burner of the Incandescent Gas Light Company, the manufacture of which was recently inspected at the works of the company in Palmer Street, Westminster. This burner, which is on the Welsbach system, was brought out several years ago, but has since been so altered and improved as practically to constitute a new article. It consists of a mantle which is formed of an open mesh material, and is suspended over a Bunsen gas burner. On being brought to a white heat by the flame it gives out a bright glowing light due to the incandescence of the mantle, the basis of which is cotton lace, impregnated with a chemical solution of certain minerals. The lace is dried and the cotton fabric burned out, leaving a mantle which consists solely of the mineral with which the fabric was originally impregnated. After further treatment with collodion the mantle is ready for use. The points of recent improvements in this mantle relate mainly to the chemicals used in its preparation. The results are stated to be that, whereas formerly when burning 3.75 cub. ft. of gas an hour an illuminating power of from 26 to 28 candles only was obtained, with the mantle in its present form, burning the same quantity of gas per hour, a light of 60 candles is obtained. Subject to the contingencies of practical use the life of a mantle is put at 800 hours. The advantages of the incandescent system are purity of the atmosphere, owing to perfect combustion, a diminution of heat, and a great economy of gas, which, according to Professor Renk, amounts to as much as 50 per cent. as against the fishtail or the Argand burner. The company are now introducing a form of incandescent lamp for street use.—*London Times.*

The Baltimore & Ohio's Cut-off at Harper's Ferry.—The new Baltimore & Ohio route through Harper's Ferry was put in operation recently, and after that hour the old route, from Sandy Hook and through the village of Harper's Ferry, about 2 miles altogether, will be abandoned and subsequently dismantled, including the railroad portion of the old bridge. The improvements, made at a cost of about $250,000, include 2 miles of double track, a tunnel 875 ft. in length, under Maryland Heights, and a new iron bridge of nine spans and over 1,000 ft. in length, over the Potomac River. The bridge is of considerable elevation, being 9 ft. higher than the old bridge, and built to stand any freshet likely to occur, and also to allow free passage for canal-boats underneath. The old line from Sandy Hook, as will be remembered by travelers familiar with the route, was close alongside the water's edge, while the new line takes considerably higher ground, and some distance from the river bank. The improvement was made entirely under direction of the Baltimore & Ohio Engineering Department. The junction of the Valley Road at the Ferry has also been changed to meet the improvement.—*Baltimore Paper.*

Chinese Obstacles to Railroad Building.—The late Mr. Charles Hill, who was actively interested in the first unfortunate railroad built in China, tells a story of the opposition met at the hands of the natives to the laying of rails, and which finally resulted in the tearing up and destruction of the road and property. In one instance it became necessary to pass the house of a widow, and to fill up a little pool of stagnant water near by. She immediately asserted that the spirit of her husband would not rest easy in his grave with the railroad running between her house and it, and that the spirits protecting them would be smothered by the filling up of the pool. The natives gathered in some force to prevent the laying of the rails, and Mr. Hill found himself deserted by his workmen and left alone to face the mob. Starting on a retreat, he was followed by the hooting assemblage for several miles, and finally came to bay on a narrow foot-bridge crossing a river. Armed with a strong cudgel he defended himself, and as fast as his assailants came up knocked them into the river, rendering them unconscious, but never learned what harm he had done. They were armed with long bamboo poles with which they prodded him on the legs and body, inflicting wounds the scars of which he carried until his death.

Lighthouse without an Attendant.—A new lighthouse has been recently completed in the estuary of the Gironde in France. It stands on an isolated rock, and its chief peculiarity is that it is unoccupied, although its lamp is burning perpetually. In order to do away with the lonesome life which is led by such keepers as those having charge of the Eddystone Light in England, the French engineers have devised a method by which the usefulness of the lamps could be maintained without constant personal attention. The lamp which is used will burn continuously for one month without being trimmed or replenished. The burning fluid used is an ordinary mineral oil. The tube in the interior of the lamp is furnished with a wick having a thickness three times as great as that usually employed in lamps. Around the burning surface of the wick is a cake made of a patented preparation consisting largely of carbonized tar. This protection assures the operation and uniformity of the flame. A chimney made of mica is placed around the flame, and this gives an increase in the power of the light. The supply of oil is from a reservoir containing .88 oz., the lamp consuming 1.8 oz. each hour. To provide for the reservoir being furnished with sufficient fuel, a gauge is fixed at its side that governs the supply flowing in from another reservoir at a distance, and this gauge permits just 1.8 oz. per hour to percolate from the little supply-pipe into the supply reservoir. The diameter of the lantern is 56 in. The light can be seen 12 miles at sea. The wick is cleansed and drawn up gradually by the action of the tar cake at its mouth. The French Government is also said to be arranging to put up other lighthouses in which a perpetual electric light can be controlled by wires running through a submarine cable to the land.

Method of Baling Cotton.—The consular reports of the State Department for December call attention to the fact that there is a great deal of trouble experienced by foreign importers with the baling of American cotton. The jute covering is so torn that the cotton is exposed to mud, fire, water, and theft. Of the original six or eight bands, two, three, four, and sometimes more are loose and broken by the time the cotton reaches its destination, allowing it to take up dust, dirt, mud, and water when exposed. In contrast with this the packing of the Egyptian and Indian cotton is very much superior. Both Egyptian and Indian have close, compact, tough coverings, are rather long and smooth, leave little or none of the cotton exposed, are easily and plainly marked, and are wrapped close and bound strong and tight. Along the sides the firm's or seller's name appears. On both ends the kind of cotton is indicated to aid in identification should one end be torn off in handling, as sometimes happens. Thus, in the case of Indian and Egyptian cotton, mixing of bales and bales without marks seldom if ever occur; on the other hand, with American cotton both happen very frequently—too frequently, hence the complaint. In addition to this it is claimed by the Lloyds that the vessel which will hold from 16,000 to 18,000 bales of Indian cotton can take in only 6,000 to 10,000 of American, when according to the ratio of weights they should take in 14,000. The fear which was formerly entertained that the enormous pressure used in India would injure the fine fibers of the American cotton has proved to be groundless, from the fact that the Egyptian cotton with as fine or finer and longer fiber has stood a greater pressure. The cotton should be perfectly dry, in order that no caking and fermentation may occur in the inside. This is a matter that certainly deserves the attention of American shippers, and is of the utmost interest to American manufacturers.

Lewis and Hunter's Coaling System.—In the ordinary method of loading coal from colliery wagons into ships a large amount of breakage is caused and clouds of dust are produced by reason of the coal having to fall from a considerable height, sometimes as much as 24 ft. With the view of obviating these evils, which are a source of pecuniary loss, Sir William T. Lewis, General Manager, and Mr. Charles L. Hunter, Engineer, of the Bute Docks, Cardiff, have invented a system of shipping coal by which the greatest fall is only 5 ft., and the mineral is quietly deposited in the hold of the ship. It consists in tipping the coal from the colliery wagon into a carrying-box having a coned valve-bottom which can be released at will. These boxes hold a 10-ton wagon-load of coal each, and as they are only about 5 ft. deep, it follows that only a portion of each load has even that short distance to fall. As soon as the carrying-box is filled it is raised by a traveling crane worked by hydraulic power, and lowered into the hold of the ship. Directly it reaches the bottom the coned valve is released and the coal glides quietly out with hardly any break-

age. The box is then raised and transferred to the loading-stage for another charge, which is quickly tipped into it and as quickly transferred to the ship. The system has been adopted by the Bute Docks Company at their Roath Dock, where a series of the traveling cranes are at work on lines of rail extending over 2,000 ft. of quay space. The cranes are self-propelling, and are not only movable and provided with a swing motion of some 40 ft. radius, but they also have a derricking motion, so that they can plumb both hatchways and coaling pits at will. This derricking motion also enables the crane-man to steer the loads clear of the funnels and rigging of the vessels. The *maximum* speed of loading is 300 tons per hour per crane, and it is stated that 298 tons of coal have been shipped in an hour by one crane. With this system as many as four cranes, each lifting 10 tons of coal, have been employed simultaneously in loading the same vessel, as the cranes can be brought into such positions as to plumb the steamer's hatchways. A model of the system was recently exhibited at the Coal Exchange, London, where it attracted merited attention.—*London Times.*

The Thinnest Metal Sheet.—An interesting metallurgical achievement has been lately recorded at the Hallam Tin Works, near Swansea, Wales, a metal sheet of the finest appearance and most marvelous thinness ever yet produced. The details show that the iron from which the sheet was rolled was made on the premises, worked in a finery with charcoal and the usual blast, afterward taken to the hammer to be formed into a regular flat bottom, from thence conveyed to the balling furnace, and, when sufficiently heated, taken up to the rolls, lengthened, and cut by shears into proper lengths, piled up, and transferred to the balling furnace again; when heated it was passed through the rolls, back again into the balling furnace, and, when duly brought to the proper pitch, taken to the rolls and made into a thorough good bar. On being taken now to the tin mills and rolled until it became thinner than 23 grains, and afterward passed through the cold rolls, to give it the necessary polish, it stands on record as the thinnest sheet of iron ever rolled—that is, the data show a sheet of 10 × $5\frac{1}{4}$ in., or 55 in. surface, and weight but 20 grains, which, being brought to the standard of 8 × $5\frac{1}{2}$ in, or 44 surface inches, is but 16 grains, or 30 per cent. less than any previous, and requiring at least 1,800 to make 1 in. in thickness.—*The Tradesman.*

Model of Locomotive.—We have received a photograph of a piece of work which was lately completed Mr. S. E. Mastin, of Odenweldertown, Easton, Pa., and which is worthy of note. The work is in the shape of a miniature locomotive of about one-sixteenth size. It is made to represent an express locomotive which was built for the New York Central & Hudson River Railroad in 1889 by the Schenectady Locomotive Works, and is made entirely of wood and cut out in full with a penknife. Mr. Mastin is not an engineer, nor has he ever worked on a locomotive; but the work on which he spent five months and two days should win for him a situation in some locomotive works, as he would in all probability make a suitable man for any works of the kind, as his sole desire is for that kind of occupation. The dimensions of the miniature locomotive are as follows:

Length over all	3 ft.	$1\frac{3}{4}$ in.
Height to top of stack		14 "
" " " " cab		$13\frac{1}{2}$ "
Width of cab		$8\frac{1}{4}$ "
Diameter of boiler		$4\frac{3}{4}$ "
" " driving-wheels		$5\frac{3}{4}$ "
" " truck "		$2\frac{3}{4}$ "
" " cylinders		2 "
Length of "		$3\frac{1}{4}$ "
" " boiler	2 ft.	

Time of building, five months and two days.

Mr. Mastin will send photos to any locomotive shop wishing them by writing him.

The photograph gives an excellent representation of a locomotive, and it is only by close examination that it appears that it is not taken from a full-sized machine.

Compound Locomotive of the Richmond Locomotive Works.—A compound locomotive engine of the ten-wheeled type, built by the Richmond Locomotive Works, has recently been tested on the Big Four Road. The engine is a two cylinder compound with cylinders 19 in. and 30 in. × 24 in. The weight of the engine alone is 68 tons, and the drivers are 56 in. in diameter. The steam pressure is 180 lbs. to the square inch; the driving-wheel-base is 11 ft. 10 in.; the truck-wheel-base, 79 in.; the total wheel-base being 23 ft. $\frac{1}{2}$ in. The length over all with tender is 58 ft. 2 in.; the weight on the drivers is 107,100 lbs.; the weight of tender, running with coal and water, is 79,000 lbs. The boiler is of the Belpaire type, and is 58 in. in diameter, with a shell $\frac{9}{16}$ in. thick. The fire-box is 107 in. long by $41\frac{7}{8}$ in. wide; the grate area is 31 sq. ft.; the fire-box has a heating surface of 172 sq. ft., and the heating surface in the tubes is 1,750 sq. ft. There are 241.2 in. tubes. The driving-wheel journals are 8 in. in diameter by $9\frac{1}{2}$ in. long; the truck wheels are 28 in. in diameter, with journals $5\frac{3}{4}$ in. in diameter by 10 in. long; the valve travel is $5\frac{1}{2}$ in. The engine was designed by Mr. C. J. Mellen, Chief Draftsman of the establishment, who also designed the engines and machinery for the United States battleship *Texas.* The reported saving in fuel runs from 30 to 35 per cent. A compound of the same type has been in continuous service for 14 months on the Philadelphia division of the Chesapeake & Ohio Railroad, and has made a record of saving 21 per cent. in fuel over 22 simple engines of the same class. The cost of repairs has been no more than other engines, and it has been run in chain gang methods with the rest.

Railroads in Japan.—The railroads of Japan are solidly constructed and carefully run, says the Philadelphia *Telegraph.* The gauge is 3 ft. 6 in., and the cars are generally 18 ft. long. There are first, second and third classes, and the fares are for several classes 1, 2 and 3 sen (cents) a mile. The Japanese are great travelers, and more than nine-tenths of the travel is of second and third class. The rate of speed is uniformly about 20 miles an hour. The trains are run on what is known as the "staff" system, and a train is not allowed to leave the station where it meets another until the conductor has received from the conductor of the other train a symbol called a "staff," which is his evidence that he is entitled to leave. In the first-class carriage, which is either one room, like our drawing-room cars, or in three compartments, like the English, one finds cushion seats, wash hand bowls and water-closets, and generally a teapot and cups, the former occasionally replenished with hot water. If this is lacking, the passenger can buy on the platform at any station a teapot full of tea and a cup for $2\frac{1}{4}$ cents. The teapot is pretty enough to bring a quarter in this country, and the cup would be cheap at 10 cents. You buy the whole "outfit" and could carry it away if you pleased. As a rule, the pot and cup are left in the car and about 60 per cent. of them are recovered by the venders. The railroads in Japan are partly owned by the government and partly by private stockholders, but the rates and rules of the government roads govern the others also. At all the stations are overhead bridges, and crossing the track at grade is prohibited, as in England. The stations are roomy and neat, the platforms ample, and at both ends of the platform the name of the station is conspicuously posted. The passenger shows his ticket on going through the gate to his train, and surrenders it at the gate on leaving. No conductor enters the cars. We also miss the familiar visits of the enterprising young man who sells newspapers and popular books, and who loads our seats at home with lozenges, photograph albums, comic periodicals, vegetable ivory, matches, chewing-gum, and other merchandise.

Electricity as a Motive Power.—The report on street railroads of the Massachusetts Railroad Commissioners was presented recently. It shows an increase of 214 miles of electric roads and of over $25,000,000 in capital so invested. Of the comparative economy of electric motive power it says:

"We must conclude, taking everything into the account, that there has been thus far no demonstration of the superior net-earning capacity of the electric as compared with the horse system, but rather the reverse. It is not, however, intended to raise the inference that the electric system is or is likely to prove, under conservative and proper management, a serious financial failure. The conditions attending its further and fuller development will probably be found to differ in no essential respect from those attaching to the old horse-railway system, or to the steam-railroad system. A well-located and well-managed electric railway, it may be fairly said, stands a similar chance of financial success with a well-located and well-managed steam railroad or horse railway. Upon the present showing and outlook, it certainly stands no better chance. If badly located or badly managed, there clearly has not been manifested as yet any miraculous power in its peculiar system of locomotion to save it from the familiar fate of the steam railroad or horse railway when struggling under the same difficulties.

"It can and should be said, however, without hesitation or qualification, that the electric system has not shown or indicated any such margin of profit as to justify the expectation of more than moderate and ordinary returns on money legitimately invested in it. The idea, which seems to have obtained some currency, that the electric railway system is a bonanza of rare and inexhaustible wealth, is clearly a delusion, and has doubtless proved to some a snare. The absolute cost and ex-

pensiveness of the system, under the most conservative, able, and honest management, are sufficient to task its earning capacity to the full limit. There is no margin for fictitious or inflated capitalization. It presents no safe or inviting field for speculative enterprise or manipulation, unless it be to the unscrupulous operators of an inside ring who are willing to practise on the credulity of a misinformed public. Wherever there is reason to believe that water has been, or is about to be, injected into the stock or bonds of an electric-railway company, the only safe course is to let its securities severely alone."

Rapid Method for the Determination of Manganese in Manganese Bronze.—The following method was originated by Mr. Jesse Jones, Chief Chemist, and is in use in the laboratory of William Cramp & Sons, Philadelphia, Pa., for the determination of manganese in manganese bronze. It is an adaptation of a well-known method in common use for the determination of manganese in iron and steel. A determination can be made in less than one hour, and as the amount of manganese in the ordinary run of work seldom exceeds 0.10 per cent., the method gives fairly satisfactory results.

The Method.—Dissolve 5 to 10 grams of drillings in nitric acid of 1.20 sp. gr., using a large beaker to avoid frothing over. An excess of acid must be avoided, as it interferes with the precipitation of the copper by hydrogen sulphide. When solution is complete, transfer to a 500 cc. cylinder without filtering out the precipitated stannic oxide. Make up to 300 cc. and pass a rapid current of hydrogen sulphide from a Kipp's apparatus until the supernatant liquid is colorless. Decant off through a dry filter; 180 cc. corresponding to 3 or 6 grams of sample, and boil down rapidly to about 10 cc. Transfer to a small beaker and add 25 cc. of strong nitric acid. Boil down one-half, make up with strong nitric acid, boil, and add one spoonful of potassium chlorate. Boil 10 minutes and add another spoonful of potassium chlorate. Boil till free from chlorine, cool in water, and filter on asbestos, using filter pump. Wash with strong nitric acid through which a stream of air has been passed. When free from iron wash with cold water until no acid remains. Place the felt and precipitate in the same beaker and dissolve in ferrous sulphate, using 5 cc. at a time. Titrate back with permanganate until a pink color remains. Deduct the number of cc. used in titrating back from the number of equivalents of ferrous sulphate used and the remainder shows the manganese in the amount of sample taken.

Permanganate Solution. Dissolve 1.149 grams potassium permanganate in 1,000 cc. water; 1 cc. equals 1 mgr. manganese. Check by dissolving 0.1425 grams ferrous-ammonium sulphate in a little water and acidulating with hydrochloric acid. This should precipitate 10 mgr. of manganese. If not, apply the factor of correction.

Ferrous Sulphate Solution.—A solution of ferrous sulphate in 2 per cent. sulphuric acid, so dilute that 5 cc. corresponds to 10 cc. permanganate solution. This is best made by trial and dilution.

Crank Axles.—In a letter on this subject by Mr. Clement E. Stretton, the indefatigable investigator of locomotive history, published in the *Railway Herald* recently, he says:

"There is no question that the first inside cylinder engine, having, of course, the double-cranked axle, was the *Planet*, designed by Stephenson toward the close of the year 1829, which commenced work upon the Liverpool & Manchester Railway, October 4, 1830. It was a striking improvement upon all previous passenger engines. The cylinders were placed 'inside,' under the smoke-box, the driving-wheels were at the trailing end, and a double-cranked axle was employed. The frame was of oak, plated on both sides with iron, and the driving-axle was above the frame.

"The cylinders were 11 in. diameter, 16 in. stroke, and driving-wheels 5 ft. diameter. During the time this engine was under construction, Stephenson built another engine for the Stockton & Darlington Line, the only difference being that it had four large wheels, and these were coupled; it was also named *Planet*. The fact that two engines were built in 1830, and both named *Planet*, has in years past caused some trouble to writers on the locomotive; however, all difficulty is now removed by the bringing to light of the official drawings and records of both engines.

"The fact that Stephenson had adopted the cranked axle and inside cylinders for both 'single' and 'coupled' engines was common knowledge early in the year 1830. When a number of engineers went to Newcastle to witness the method of forging the crank axle, several of those present, being in favor of outside cylinders, took but little interest in the subject; but two at once saw the value of the inside cylinder system, the result being that Mr. Hackworth then designed the *Globe*, well known on the Stockton & Darlington Line, and a very close copy of Stephenson's second *Planet*. Shortly afterward Mr. Bury designed an engine named *Liverpool*, which was completed and sent to America in 1831, and of which pattern large numbers were afterward built.

"The advocates of Mr. Bury at one time claimed that he built an inside-cylinder engine in 1829, but they have been obliged to admit that this was not the case; it was said to have been built for the Liverpool & Manchester Railway. However, an investigation of facts, working drawings, and official papers shows that Mr. Bury built no engine whatever for that railway until the *Liver*, which he placed on the rails in February, 1832, and the company did not order any more than this one on the Bury design. Of course, it is well known that the *Planet*, by Stephenson, was intended to be the engine to open the Liverpool & Manchester Railway, September 15, 1830, and it was sent off from Newcastle in due time, but having to go by sea from Newcastle to Hull, and by canal from Hull to Manchester, delays took place, and the engine was not delivered by the boat companies until early in October, or fully a fortnight after the opening. Under these circumstances *Northumbrian* opened the line, and eight engines, instead of nine, were in the procession.

"As to frames, the 'bar-framing' was first made at Newcastle, and has been generally adopted in America; but it is an English invention, and was sent out from this country in 1828."

New Signal Device.—There was an exhibition recently before the Royal United Service Institution of a new device for signaling at sea by night or day. It was the invention of Mr. C. V. Boughton. The object aimed at is to signal by the Morse alphabet, displaying simultaneously all the symbols which go to make up a letter or signal, instead of flashing them from the mast-head in succession. It is claimed that 100 letters were sent per minute by the new apparatus. The theory of the telephotos, as it is called, is a production of the symbols by electric lighting in lamps mounted on a long shaft, 10 lighted lamps in a line of 5 ft. length representing a dash, and one light a dot. There is an unlighted interval between each dot or dash of at least 5 ft. in length. The number of lamps required is 53, and these are mounted on a shaft 27 ft. long. The switch-board is only 11 in. × 14 in., and may control lamps for two shafts. It is fitted in a case mounted on a pedestal. At one end of the pedestal is fitted a keyboard, corresponding to that on a typewriting machine, and the keys have raised on their under sides the Morse characters, for the respective letters, in brass with platinum points. The crossbars, 106 in number, are flexible and imbedded in hard rubber. The pressing down of the key makes contact with such crossbars as are immediately opposite to the platinum-pointed brass projections on the key corresponding to the Morse symbols which represent the particular letter. Wires are led from each crossbar to a lamp on the shaft, and thus the signal corresponds with the symbols. A groove under the keys contains a number of fine steel balls similar to those used in the bearings of cycles, with $\frac{1}{16}$ in. of lost motion the thickness of the key. The pressing down of the key causes these balls to lock all the other keys. The lamp is of special construction. It is flatter in the face than the usual incandescent globe, resembling an ordinary door knob, and the filament of 10 coils is placed crosswise in order to secure the greatest light surface. Each lamp is fitted into a special bell-mouthed casing with a parabolic metal reflector, and in front there is a lens screwed on. This latter, it is said, has the effect of screening the expiring incandescence of the filament of the lamp. Of course it will be understood that the lamps may be used for any or all successive letters, for the lamps used are determined by the spacing necessary for the symbols in the letter, and here it may be stated that where practicable the symbols are as far divided as possible. Thus "m," equal to two dashes, would require 10 lights at either end of the 27-ft. shaft to be lighted, while "i," equal to two dots, would require the extreme end lights on the shaft to be illuminated. An important consideration is that by auxiliary mechanism a permanent record in writing of the signal given is kept. Above the keys for making the electrical contact with the crossbars is a cylinder with an adaptation of the ordinary typewriting machine, and 36 double magnets for throwing the Roman type of the symbol displayed on the proper ribbon. This recording apparatus may be kept under seal. There are a great variety of means of applying the invention. Several navy officers, while recognizing the ingenuity displayed, seemed inclined to regard it as much too intricate, and therefore liable to get out of gear. Admiral Colomb expressed a desire for a more intimate acquaintance with the mechanism, which he seemed to regard as unique in conception.—*Philadelphia Record.*

SIGNAL APPARATUS IN USE ON THE GRAND CENTRAL RAILWAY OF BELGIUM.*

By Leopold Kirsch.

In 1889 the management of the Grand Central Railway of Belgium exhibited at Paris the apparatus which is used on their line for the manipulation of points and signals which are some distance from the signal cabins, and since that time the apparatus in use has been greatly increased. Experience has shown that it is thoroughly adapted for the work which it has to perform, and leaves absolutely nothing to be desired in the transmission of motion to distant points. The mechanisms are simple, light, easy to locate, compact, and comparatively inexpensive; they are, furthermore, absolutely safe, and in adopting them certain elementary cautions have been taken.

General Considerations.—Among the causes which can exert a disturbing influence on the action of the apparatus there are three which should receive the particular attention of the engineer: The influence of the temperature, that of elasticity, and the breaking of wires. The first question brings up the inquiry whether or not it is necessary to provide the apparatus with compensators.

This question is a matter of discussion, and we would refer to an interesting notice published by Mr. Colin in the *Revue Générale de Chemins de fer* for August, 1893, in which he discusses and calculates the strains which should be put upon wires for a double transmission in order to operate a point, and assure its perfect action in spite of the variations of temperature, and without having recourse to the use of compensators or regulators.

According to his theory, at the time when the apparatus is set up, the tension of the wires should be ascertained, account being taken of the distance, the size of the wire, the distance between supports, the prevailing temperature, and the variations of the temperature admissible for the locality where the work is done. We would add that it is also necessary to take into account the contour of the line of transmission. The contour may have a very great influence upon the resistance, and consequently upon the initial tension which must be given to the wire. The variation in tension is considerable, since even adopting with Mr. Colin 1,050 ft., 1,312 ft., and 1,640 ft. as the limiting length which should not be exceeded with wires of .14 in., .173 in., and .2 in. in diameter. The tension with the lowest temperature in our climate may vary respectively from 364 lbs. to 697 lbs. and from 465 lbs. to 1,096 lbs. and from 611 lbs. to 1,320 lbs., according to the distance between supports, and may show a variation of 344 lbs., 434 lbs., and 571 lbs., according as the temperature is lower or higher.

The application of this theory does not seem to us to be one that can be recommended. It makes the original application and maintenance of the required tensions a delicate and complicated operation. With temperature charts taken from observations in our climate, the tension of a wire may vary from a little over 50 per cent. to nearly 100 per cent. Now, in a case of absolutely straight transmissions these changes of temperatures have a relatively slight influence on the operation, which becomes very different when the transmission runs around curves or polygons, or as sudden changes in direction. In the latter case, which are the most frequent, the difficulty of the manipulation will vary almost in the same ratio as the tension of the wire, and will often impose upon the signalman a useless amount of work, and will make him accustomed to an increase of resistances which may be very great without causing any anxiety as to the results, considering them due to natural or abnormal circumstances. On the other hand, the length of the transmissions ought not to exceed 1,775 ft. when points are to be moved, but will almost always be more when distant signals are to be operated. It will, therefore, be very often necessary to use a wire more than .2 in. in diameter, and thus considerably increase the disadvantages which have been pointed out above. Furthermore, as it is prudent for signal work to use no wire except that of a very high resistance, and one which is, therefore, high priced, and as the construction of compensators is very simple and inexpensive while their operation is positively certain, a large part of the expense incurred by the use of compensators will be balanced by the saving obtained in transmission wires. We are, therefore, of the opinion that it is necessary—

1. To use transmission wires that are as light as possible, and we have selected for our own purpose cast-steel wires 1.3 in. in diameter, which have a breaking strain of 90,000 lbs. per square inch of section and a very high limit of elasticity.

2. To provide suitable compensators for most lines.

But it is possible to dispense with the use of compensators when it is desired simply to bring the manipulation of a certain number of independent points, which are near each other and at short distance from the point of operation, to a central platform; and in this case it is well to regulate the tension of the wires three or four times a year in order to lessen the lost motion. When a lever is moved the strain which is put upon it is not transmitted directly to the apparatus to be moved. This strain must first overcome the inertia of all the elements of the transmission and overcome all friction and all resistances. An increase of tension is caused in the liquid conductor producing an elastic elongation, which is generally called the lost motion. This latter increases with the distance of transmission, the weight of the parts, the distance between the supporting points of the wire and the various stronger resistances. The stroke at the point of attachment of the wire to the manipulating lever ought, therefore, to be equal to the useful stroke of the apparatus to be moved, increased by the lost motion and a certain excess for putting the lever in the stop notch. Theoretically, it is possible to guarantee a good action of the apparatus, since it will be sufficient to vary the stroke of the lever according to the necessities of the case; but practically this is not so with the necessities of construction, interlocking, etc., that are required to give the operating levers a uniform and constant stroke. Then, in certain cases the lost motion may exceed the highest admissible limit. It is true that, in considering the location and construction of the transmitting parts, and the different details in laying out the supports for the wires, etc., it is possible to diminish the inertia as well as the passive resistances a great deal. Thus, for example, in order to carry a transmission wire we have obtained a very low price for stamped steel pulleys which only weigh about .6 lbs., in which the diameter of the axis of rotation is to that of the circle over which the wire rolls in the very favorable ratio of 10 to 145, the weight of which does not rest upon the wire. Furthermore, for sudden changes of movement we find that we can replace chains by steel cables, which are very flexible and pass over pulleys of large diameters carefully mounted, etc. But whatever we may do, the transmission and the manipulating apparatus always offers a certain resistance to motion, and this resistance will vary greatly for two transmissions of the same length, but of different contour. We have, therefore, never been able to entirely do away with the lost motion. Nevertheless, if everything works normally, it is possible in many cases to abridge this lost motion by keeping it within the admissible limits of the actual stroke of the operating lever. In order to accomplish this the stroke of the operating parts of signals and points in the Asser & Thorel, Marti, and State Railway apparatus has been divided into three periods: unlocking, movement and relocking, and the two end periods have been given greater or less proportions. But when for any cause whatever the transmission does not act normally, especially when the wire is caught, this arrangement will not suffice to insure a satisfactory action. In fact, if in a similar case the signalman should continue to haul on the transmitting wire he would stretch this wire, and might very frequently set his lever in the stop notch. He would, however, be compelled to exercise a supplementary effort proportionate to the length of the stroke remaining for the normal motion of the lever; but whatever the cause might be, the strain would be less as the wires were smaller, the distance longer, and the leverage of the operating parts greater. But, on one hand, in order to facilitate the movement under normal conditions, it is desirable to use wires as light as possible and operating levers as powerful as possible. On the other hand, even for small stands the length of transmissions will frequently exceed 3,000 ft. Therefore the signalman would frequently, by a very slight supplementary pull, be able to stretch the transmitting wire sufficiently to set the lever at the end of its stroke, and thus falsify the play of the interlocking arrangements.

The elasticity of the wires constitutes a serious cause of danger which cannot be suppressed, but it is possible to guard against injurious action. For this purpose we have also divided the total stroke of the operating parts, properly so-called, into three practically equal parts, so as to give as great importance as possible to the two extreme periods during which the unlocking and locking is done, and upon which the positiveness of the action depends. We have, at the same time, so arranged our interlocking apparatus as to do all of its work during the first of these three periods—that is to say, before any change has taken place in the position of the points and signals. These two precautions are, however, insufficient in our opinion to entirely do away with the danger due to the elasticity of the transmitting wire, and we have, therefore, adopted for our operating levers a special type of

* Bulletin of the International Commission of the Railway Congress.

construction and operation which constitutes one of its peculiarities, and one which has been perfectly satisfactory to us and will be described later on.

The third cause of disturbance which we have alluded to—namely, the final rupture of the wire—ought to receive most careful consideration. In fact, if we do not take special precautions on this point, the breakage of the return wire may have the effect of keeping the signals to track clear. If the distance is long, and if the first period of the stroke of the moving parts is relatively small, it would be possible for the signals to be set at clear or in a doubtful position, or a point might be slackened off and even set for the opposite track. We have, therefore, so arranged our operating details that in case of the breakage of a transmitting wire, the signals are immediately and automatically brought to danger, and the points are held immovably in the position which they occupied at the moment of the breakage of the wire; so that if the wire which moves a point breaks before the signal in connection with it has been set to clear, no danger can result therefrom. Finally, the signalman is immediately and automatically notified of the breakage of the transmitting wires, and he cannot move any of his levers which act in conjunction with the line that is out of order until it has been repaired.

The operating parts, properly so called, and especially those of the points ought also to satisfy certain special conditions. Thus, for example, while the stroke of the levers is kept constant, it should be possible to easily and quickly vary the opening of the points and remedy any slight defects inherent in the manufacture and setting up, the spreading of the track, or the stretching of the wire and the connections, etc. All whipping of the points on the passage of the trains should be done away with. The points should be fitted so that they are held by their feet up against the rail in such a way that breaking or injury to an important part would not cause any damage to this particular point. In some installations it is necessary to set up between a point and the signal which protects it such an interlocking that when the signal has once been set to clear, the position of the point cannot be modified until it has been passed by the train for which the signal has been set to clear, and the latter has been brought back to danger. Whatever this arrangement may be, it should be possible to correct it for anything which is excessive.

Finally, it may be necessary to provide some points with an auxiliary which prevents them from being changed in position during the passage of a train. This is especially the case where an important point is located at too great a distance from the operating lever for the signalmen to be positively certain at all times whether it is thoroughly locked in position.

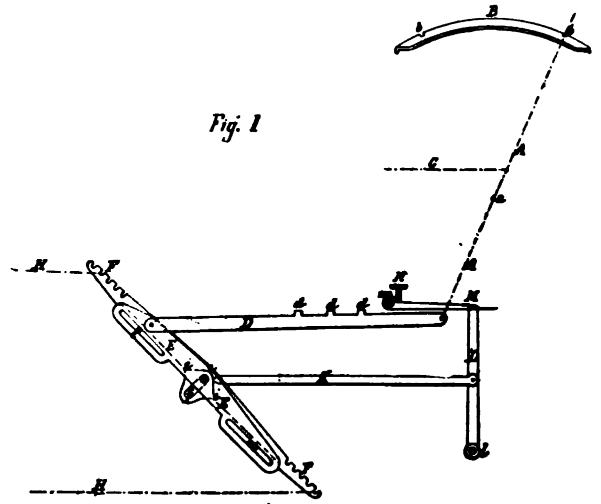


Fig. 1

Operating Lever.—Our operating lever is formed of a rectangular bar of iron A, fig. 1, turning about a horizontal axis a; its movement is guided by quadrants fastened to the casting B; it can be moved and set into its two extreme positions by means of the two stop notches b b that are made in the quadrant. The rod C connects the lever with the interlocking parts, which are carried on a horizontal table located beneath the floor of the cabin.

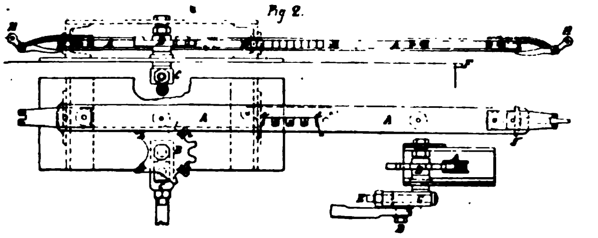
The operating lever does not act directly upon the two transmitting wires, but is attached to them by a combination of pieces including: 1. The rod D carrying three lugs d; 2. An equalizing lever e, which turns about a horizontal fixed axis and is pivoted to the rod D and has two buttons E, by which the distance which separates them from the axis of rotation may be varied at will; 3. A false balanced lever, F, having an elongated slot, F, at its center, through which the pivot-pin of the lever E passes; it rests against the two buttons E, and at each end one of the transmission wires H is attached; finally there is the cam i i i, against the center of which the end of the fork K rests; 4. The fork K sliding at one end around the axis of rotation of the balanced lever, and pivoted at the other end to a crank lever, L; the latter is at the same time keyed upon a horizontal rotating shaft, l, and supports by means of the step M, which moves around its shaft m, a transverse bar, N, called the locking-bar.

This arrangement of parts may seem somewhat complicated, but I wish to remark that all the parts which I have just cited are interchangeable and identical one with the other.

Under normal circumstances the tension of each of the two wires of one transmission are practically the same. The false balancing lever F rests upon the two buttons e and transmits the movements of rotation given to the balanced lever E by the rod D; but if for any reason one of the two wires of transmission cannot follow the movements of the other, the difference between the tension of the two wires becomes considerable and the equilibrium is broken; the false balancing lever F then turns about one of the buttons e, its cam, i i i, moves out from the axis of rotation and pushes against the fork K. The crank L then turns, sets the foot M free; finally the locking-bar N falls, and by means of the lugs d locks and fastens all of the connections controlled by D.

By moving the buttons e more or less, the sensitiveness of this arrangement can be regulated at will, and by giving the locking-bar N a suitable length it renders absolutely immovable all the levers which depend upon one another, so that the breaking of a wire produces the same effect as the locking of that wire; its action is felt immediately without its being necessary for the signalman to make a trial of an interlocking lever.

Fig 2.



This method of operation gives every possible security, not only because the sensitiveness of the balanced levers can be regulated at will, and the signalman notified of every disarrangement of the transmitting parts, but also because the rupture can have no injurious results, while the signalman is notified that there is some danger to look out for. For example, when snow is on the ground each movement of the eccentric banks up a certain amount of snow in between the points of a switch and the main rail. When it has been packed to a sufficient thickness and hard enough so that the point begins to bend, but long before this wedging out will be at all dangerous, the leading wire has such a strain upon it as to prevent the operating lever from dropping down into the stop notch, thus increasing the resistance, and the locking-bar N then rigidly fastens all the parts, so that there can be no motion whatever. Not only is the signalman prevented from causing any disarrangement of the signals, but he knows what line is giving the trouble, and consequently examination and repairs are very easy.

Finally, we would say that an accessory arrangement permits the locking-bar N to be easily raised, and all the parts to be set back into their normal arrangement.

Detail for Operating the Points.—This detail includes two principal parts, A and B, fig. 2. The part A is composed of two bars of iron riveted together and held parallel to each other by four circular separating pieces and by a part of the rack a. This part of a rack is placed exactly in the center of the length of A and beneath a notch, b c d e, cut into the upper bar. Part A has a horizontal movement which is guided by two chairs fixed upon an iron ground plate, and its stroke is limited by the lugs g at the ends of the bars.

The part B is the pinion toothed over one-half of its circumference and keyed upon a vertical shaft. The teeth, according to the position occupied by A, slide between the two bars and mesh in with the teeth of the rack. Its upper face carries four projections h h i i placed at the level of the upper bar of A.

When the part A is at rest in one of its two extreme positions, two of the projections, $h\ i$, rest against the upper bar and hold the pinion B immovable. When the part A has made about the first third of its stroke the first tooth of the rack meshes in with the first tooth of the pinion, and the projections $h\ i$ are opposite the notch $b\ c\ d\ e$ in the upper bar, and are therefore set free; the pinion B, which is thus rendered free, takes on the movement of the part A, and during the two-thirds of the stroke of the latter makes a turn through 180°. At this point the engaging teeth again separate and two other projections, $h\ i$, of the pinion B come up against the straight part of the upper bar, while the pinion B is once more held fast. The crank C, keyed to the shaft of the pinion B, shares the fixedness or the motion of the latter, and describes a half revolution. From the pin D of this crank a connection is made to the end of the tie-bar, which gives motion to the points. The pin D can be set by means of the screw E in the crank, and the throw of the points be varied at will, leaving that of the other parts unchanged; in this way it is possible, when so desired, to bring the points in immediate contact with the rails without exercising any pressure upon them. The rigidity of the pin B and the slight distance at which it is set from the track moves the points at once. The transmitting wires are fastened respectively to the two ends of the part A, to which they communicate their motion. If the whole had been put together by a simple connection, the breaking of the water conductor would have the effect of giving a sudden motion to the operating parts. If the transmitting wire is not provided with a compensator, the point would be apt to be moved in consequence of the tension of the leading wire; if the transmitting wire is provided with a compensator the position of the point will be completely reversed. There is one source of serious danger which we have done away with by providing the part A at each end of the spur H, which turns about a horizontal shaft and to which the transmitting wire is attached, with a spring having a constant tendency to push the spur down. The force of this spring is so regulated that when the transmitting wire is intact the spur occupies the position indicated in the engraving, and the part A can move freely. In case of the breaking of a transmitting wire the corresponding spur is immediately pushed down and drops under the lug F; the part A, therefore, cannot move beyond the first third of its stroke, and the position of the points remains unchanged, at the same time the locking-bar of the operating lever puts it out of action. The play of the interlocking parts to any point cannot be falsified by the breaking of a transmitting wire, even if this breakage should occur after the corresponding signal has been set to clear. Furthermore, the signalman has been notified of the breakage of a transmitting wire.

(TO BE CONTINUED.)

RÉSUMÉ OF ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN FOR ONE YEAR.

One year ago this month we began the regular publication of those railroad accidents that resulted in the death or injury of an engineer or fireman. With our issue for March we completed the record of the first twelve months, and an appalling record it is. That it is incomplete goes without saying, for our main source of information is the published accounts in the daily papers, and there must have been some fatal and many minor accidents that were never reported. In reviewing this list of horrors, we find that during the year there were 450 accidents resulting in the death of 108 engineers and 114 firemen, and in the injuring of 251 engineers and 223 firemen, giving an average of 37½ accidents per month. There has been no epidemic of accidents, but a steady run, and the number reported for each thirty days has been remarkable in its uniformity. The terrible accidents that were reported during the summer in connection with the World's Fair excursion trains neither raised nor lowered the average of accidents to engineers and firemen, but were merely incidental to the number that occurred with astonishing regularity. The following is a *résumé* of the accidents occurring between March 1, 1893, and March 1, 1894:

Attacked by strikers	2
Blowing out of cylinder-head	1
" " plug	1
" " safety-valve	1
Boiler explosions	29
Breaking of wrecking apparatus	1
" through trestle	1
Broken axle	2
" connecting-rod	3
" coupling-rod	6
" crank-pins	1
" eccentric-rod	1
" rails	4
" side rods	2
" truck	1
Bursting of flue	1
" " gauge glass	3
" " oil glass	1
" " pipe	1
" " steam pipe	3
Cattle on track	9
Caught between cars	2
" " locomotive and engine house	1
" by hot pipe	1
Collisions	148
Defective bridges	8
Derailments	50
Falling of tool-box lid	1
" or jumping from engine or car	37
Gas explosion in car	1
" " from furnace door	3
Hand crushed	1
Jumping on engine	1
Land slide	5
Lost tire	1
Obstruction placed on track	2
Misplaced switches	29
Powder explosion	1
Rail spread	2
Run over	6
Runaway engine and train	9
Running into snow bank	2
Shot by train robbers	2
Struck against backboard	1
" by coal	1
" " obstruction	17
" " train	16
Thrown from train	1
Tunnel roof falling	1
Uncoupling hose	1
Unknown	21
Washout	4
Total	450

Referring to this list, we find that collisions are by far the most prolific sources of danger, there having been 148 during the year; next comes derailments, at 50; falling from engine or car, 37; misplaced switches, 29; boiler explosions, 29; struck by obstruction, 17; cattle on track, 9; runaway engine, 9; and unknown, 21. Of these principal sources of accident it must be gratifying to the mechanical departments to note how few can be laid at their own doors; while the precautions taken by the operating department through the policy of the board of directors make a bad showing in the 147 collisions and 29 misplaced switches, while the road department should be held responsible for the injuries to men who were struck by obstructions or hurt by cattle being upon the track. Taking the accidents as they stand recorded, we should place the responsibility about as follows:

Mechanical department	60
Operating "	178
Personal negligence	69
Road department	104
Unassignable	33
Violation of criminal laws	6
Total	450

Thus, out of 342 accidents which are directly traceable to one or another of the departments of the railroads, the mechanical department is responsible for 60, or about 17½ per cent. of the whole. The predominance of collisions over every other form of accident simply means that suitable provision has not been made for the protection of trains; in short, that the block system is not considered necessary. As a matter of investigation, it would be interesting to learn just what these 148 collisions have cost, and how much this cost would be raised by the other collisions in which neither an engineer nor a fireman were hurt, but where cars were reduced to scrap or passengers brought into a damage-claiming condition.

Block signaling costs money, but when it is established the company has something tangible to show for its outlay;

while with a collision the only assets available is a collection of more or less worthless scrap and the quit claim signatures of the victims.

We have announced that the object of publishing the monthly list is "with the hope that such publication will in time indicate some of the causes of the accidents," and that we desire some indication of "the causes and cures for any kind of accidents that may occur." The first year of this publication seems to us to go a long way toward indicating some of these causes, and the cure for this one type is easily found in the prevention of all attempts to make trains pass one another on a single track. The absolute block system, whether it be applied in one of the common systems on a double track, or with the staff system on the single track would seem the plain, common-sense solution of the difficulty.

The operating department should also be called into account for the mistakes of its subordinates, and the rectification of such mistakes and the prevention of their repetition is so largely a matter of discipline, and discipline is so largely dependent upon the personal equation of the man in command, that we have no suggestion to offer except that a high standard of obedience to the rules of the company be demanded, and that the service be rid of men prone to make mistakes.

The road department comes in for its share of the responsibility through its neglect to observe proper precautions in construction and repairs. There is no possible excuse, for example, that 17 men should have been killed or injured by being struck by obstructions placed so near the rails as to strike a man leaning from a cab window. If tracks are so arranged that a signal-pole comes dangerously near the rails when placed in the most desirable position, that is no excuse for not putting it in a less desirable place and avoiding even the appearance or possibility of danger. Cattle are run over in innumerable quantities, but as they are almost always struck while standing, they rarely cause an accident in which any one is hurt; but the spreading and breaking of rails, landslides, defective bridges, and the like, simply mean defective watchfulness. Not that the utmost vigilance will always avert a disaster, for the damage may be done immediately after inspection, as in the case reported in March, where, on a California road, an engine crossed a bridge on an inspection trip, and on returning a few minutes later for its train, went down, killing four men; the bridge foundations having been undermined between the two passages.

Coming to the mechanical department, with its 60 accidents, of which 29 were boiler explosions, we find it difficult to point out just where reforms should begin. Of course the boiler explosions mean either careless inspection or careless handling. In a recent report made on the boiler explosions of a certain road, out of 14, 13 were shown to be directly attributable to carelessness on the part of the enginemen. A boiler does not explode unless it is too weak to withstand the internal pressure; and if it is too weak the head of the department should know it. When a boiler comes in for repairs with 84 staybolts broken and only four reported at the last inspection one week previous, there is something rotten in Denmark; yet that is an actual case of which we have personal knowledge. Engineers are dealing with a tremendous power, and the careful man fears it more and more as the years roll by. Careful, systematic inspection by men of known competency is respectfully suggested as one of the remedies to be applied in lessening the number of these accidents.

Of the other minor accidents, such as the breaking of rods, the cracking of tires, the bursting of water glasses, and the like, it is not probable that a modification of design would help appreciably. Careful inspection should be maintained; but above all the purchasing department should be brought to a realizing sense of the fact that low-priced material means poor material; that poor material means breakages, delays, and expense; and that true economy calls for the best. We have yet to find the master mechanic or superintendent of motive power who was an advocate of poor material; but we know scores who are in a constant state of worriment over the inferior supplies foisted upon them by the purchasing departments. Therefore, a few lessons to the buyers might not be out of place in order to show them that there are irons and irons, and that a metal need not necessarily be suitable for bearings merely because it is yellow and leaves a bad taste in the mouth.

When we come to those cases where men are injured through their own personal neglect, reformation seems a hopeless task. The old saw of familiarity breeding contempt is especially applicable. Men are so in the habit of swinging on and off of engines while they are in motion, and of just allowing a bare clearance between their own bodies and a passing train, that the day is apt to come when the foot slips or the clearance is cut down to the striking point, and a disabled man is the result. The men know the dangers to which they are exposed and to which they expose themselves, and the only wonder is that out of the millions of repetitions of certain movements we have only to record 69 as resulting injuriously.

In reviewing the accident record for the past year, the recommendations that are thereby suggested are that a block system of running trains be adopted wherever it is not in vogue; that the road department look well to the designing and construction of all bridges, etc., and pay particular attention to the location of posts and building, making sure that they are far enough from the rails to be beyond striking distance; that the mechanical department redouble its efforts to reduce explosions by a rigid and systematic inspection, for we take it for granted that the boiler designs are correct, or at least unchangeable, and that the purchasing department look to it that low-grade goods are not bought, even though the discounts be the most attractive in the world.

160-TON CRANE AT HER MAJESTY'S DOCKYARD, CHATHAM.

The fine crane which we illustrate on page 165 has been erected at Her Majesty's Dockyard, Chatham, by Messrs. Tannett, Walker & Co., Engineers, Leeds. The crane may be considered as a combined steam and hydraulic crane, as the hydraulic system is only used for lifting heavy loads, light loads being lifted by tackle worked by steam power, which is also used in revolving the crane. The crane in question is capable of lifting a load of 160 tons to a height of 50 ft., this being done, on the so-called direct-acting system, by means of a hydraulic cylinder fitted with piston and rod. The extreme range of the crane is 75 ft. 3 in., and the height of the jib-end sheave from the quay level is 125 ft. The full load of 160 tons is raised by means of hydraulic pressure, and there is a wire rope with block hook for lighter loads up to 30 tons. The roller-path on which the crane revolves is 45 ft. 4 in. in diameter. As will be seen, the crane is mounted on a massive masonry foundation, to which the roller path is firmly bolted. The rollers are mounted on a live ring, and, being closely packed, give a good distribution of the load. The framing of the crane is of the most massive character, a very rigid structure being thus obtained. The counterweight is fixed behind the boiler, as shown to the left in our engraving.

The boiler is of comparatively large size—namely, 18 ft. long by 7 ft. 8 in. in diameter, and is of the horizontal type. It supplies steam to three pairs of engines, of which one set pumps the water for the hydraulic cylinder, another set revolves the crane, while the third set works the wire rope tackle used in lifting light loads. After its erection at Chatham, the crane was tested with a load of 320 tons, which it carried without difficulty. The total weight of the structure is, we may add, about 500 tons.—*Engineering.*

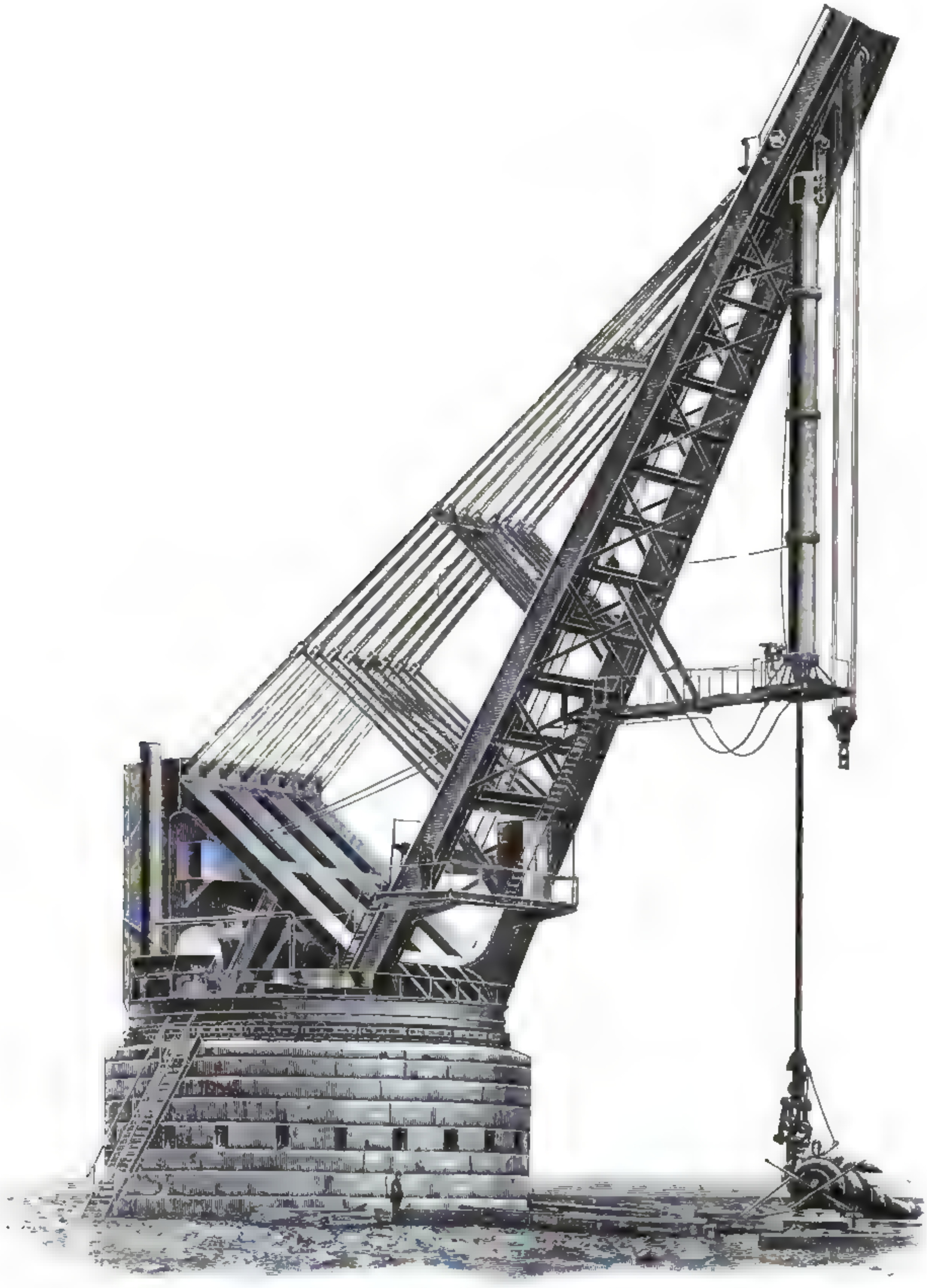
ELECTRICAL TRANSMISSION OF POWER IN FACTORIES.*

By Alexander Siemens, M.I.C.E.

In order fully to appreciate the importance of distributing power in works by means of electro-motors, a short statement of their principal features will not be out of place. Electro-motors are of simple construction, they require little attention, and are free from waste products; they require light foundations, will run at constant speed when properly wound, they consume energy in proportion to the work they do, and are easily adapted for driving any kind of machine or tool.

They consist essentially of two parts, the magnets and armature, the latter being the only moving part. It is evident, therefore, that we have little to fear if we can manage to build the armature in such a substantial manner that it runs without giving trouble. The magnets being stationary, it is only necessary to provide good enough insulation, and that presents no difficulty. The construction of an armature may be more clearly understood by considering this sample one. It consists of a steel spindle on which is strung a number of soft iron disks, each stamped to fit over a key which is sunk into the spindle, thus ensuring good driving. The conductors are copper bars, either solid or made up of strands of wire, according to the size of the machine. They are laid round the circumference and connected at one end to the commutator;

* Abstract of lecture delivered before the Birmingham Association of Mechanical Engineers.



100-TON CRANE AT HER MAJESTY'S DOCKYARD, CHATHAM.

at the other they are joined up by curved end connections, a compact arrangement, taking up far less space than the old method of wire winding. The bars are insulated from one another, and from the body of the armature, space being left at frequent intervals round the circumference for hard wood pegs, which drive the conductors.

Fine steel wire of special quality (120 tons per square inch breaking strain) is wound over the whole at intervals, thus keeping the bars from flying outward when running. An examination of this armature and a little thought will, I think, satisfy you that there is no reason why such an armature should not be a thoroughly good mechanical structure. With regard to commutators and brushes, we have all heard tales of the ravenous way motors consume brushes; brushes of copper wire, strips and gauze, as well as carbon, are alike devoured. Now, this may happen from either of two causes—bad design or bad treatment.

Of course, good treatment will not make a motor run well which is radically wrong in design, but in the matter of brushes, and motors generally, the proverb, "Cleanliness is next to godliness," applies literally. Let me give an instance of what is possible in the direction of keeping down cost of repairs and attendance. A few days ago I accompanied Lord Kelvin on a visit of inspection to the City & South London Railway, our object being to look at the armatures of some electric locomotives which my firm built for their passenger traffic some 15 months ago. These armatures had been in continuous work, and had received the usual amount of care only; they were hauled up for examination after running 26,000 miles without repair. We were informed that the brushes we saw were the original ones supplied with the locomotives, the spare set not having yet been required. A small transmission plant erected by the late Sir William Siemens at his house near Tunbridge Wells will serve to illustrate two of the advantages I have enumerated—viz., the little attention required and the absence of waste products. A pump, situated several hundred yards from the house, was formerly worked by a small steam-engine and boiler; these occupied the whole time of one man. A small electro-motor was put down in place of the steam-engine, and supplied with current from the dynamos in the main engine house. This motor has run now for 14 years very satisfactorily, and it is only necessary for the gardener who has charge of it to make one journey a week to the pump-house to fill the lubricators. Instead of the wilderness of ashes and clinkers that accumulated round the old plant, there is now a garden. We cannot avoid making ashes somewhere, but now all the ashes are produced at the main boiler-house and are easily dealt with. The electro-motor, therefore, stands in the unique position of doing the work required of it without fuss, noise, or dirt. You can put down an electro-motor to do work temporarily where it would be impossible to have any other type of motor, owing to the complicated exhaust and feed pipes. Having to light up a boiler fire every time water is wanted is a very uneconomical plan. Of course by using an electro-motor we do not avoid having to light fires altogether, but the cost of fuel and labor of lighting those fires is distributed over as many power consumers as are connected to the mains.

Again, electro-motors do not require such heavy foundations as steam-engines of equal power. In many cases their own weight would be sufficient to hold them in place, with a steady pin or two to keep the shaft in line. The high or low speeds obtainable make these motors very suitable for direct driving without any intermediate gearing. There are no reciprocating motions, as there are in most engines, and armatures are easily balanced to run at 1,000 or more revolutions per minute without vibration. With regard to speed, nothing can be more satisfactory than the way a shunt-wound motor governs itself with a varying load. The speed is just a matter of the pressure on the terminals so long as the load is within the motor's capacity, and provided the mains are of such a size that a variation from light to full load does not produce a great drop of pressure in the mains, the motor will run at practically constant speed. This fact we have proved over and over again at Woolwich. Perhaps the most successful application of electro-motors was when we substituted them for small steam-engines, which used to drive our india-rubber rolls. Formerly we could never get anything approaching steady running; a piece of raw rubber would pull the engine up, while no load meant running away. Now we can cram in rubber of all sorts, and the motor takes just enough current to make it give out the requisite power at the proper speed. This feature will be at once appreciated by any one who has to do with such intermittent work as sawing, etc. Although shunt motors run at constant speed, it must not be thought that the speed of any particular motor is absolutely fixed. It is far easier to vary speed with an electro-motor than with any other kind of engine. For varying speed we provide a resistance switch in the exciting circuit by which the strength of the magnetic field may be varied, and thereby the motor made to run faster or slower at will. A starting switch is also required. There are two handles on the switch, interlocked in such a way that it is impossible to interrupt the exciting current while current is in the armature, or to complete the armature circuit without first closing the exciting switch. The construction of this switch should be noticed at each place where the circuit is broken. The spark is taken by two pieces of carbon. This keeps the metal contacts clean and in good condition. As before stated, a motor takes current in proportion to its load, thus measuring the current forms, an easy way of estimating the power taken to drive any tool. The motor is connected to mains carrying a certain pressure; the product of this pressure, and the current measured in the ordinary units for which commercial instruments are calibrated, divided by 746, gives the electrical horse power. The power may be absorbed in a brake, or transmitted to the machine through a dynamo meter, and the brake H.P. corresponding to any electrical power is at once known. This enables us to put down a motor for any piece of work which will just do that work comfortably, being neither too small for its work nor yet wastefully large, for a motor or engine working below its proper load is always more or less inefficient. An examination of the current indicator—which registers continuously—serves the same purpose as taking an indicator diagram from a steam engine, only it is infinitely quicker. It will tell you if the motor is fully loaded or overloaded; if anything goes wrong and fails to advertise itself, the ammeter will tell you.

Every manufacturer knows that a great deal of his engine power goes in keeping the shafting and pulleys running, and what a small proportion of it is utilized at the tool points. The conditions aimed at in electrically-driven plant, and which will go a long way toward cheapening manufacture, are to supply each tool with just enough power to do its work, and to keep it from absorbing any when not in actual use. In making extensions it is often found that shafting is too weak to bear any additional strain, having been put down as small as possible for the sake of cheapness or to save weight. With electric motors there is no such trouble; each tool having its own motor, it is only necessary to provide mains of sufficient section to carry the ultimate load, or even less at first, as it is a far simpler thing to lay down another main alongside the existing one than it is to thicken up a shaft. Unlike a heavy shaft, a large cable does not involve a heavy driving cost; a small motor may be driven through a large cable, and yet the efficiency of working be every bit as good as if that cable carried current up to its safe limit. Each motor added produces a loss in the cable proportional to the work it does. It is difficult to alter the speed of individual machines when driving by belts; some such arrangement as cone pulleys or step cones must be used. On the other hand, electro-motors are well under control in this respect.

Having now dealt with the advantages of the electric system, and the disadvantges of the old, I will proceed to describe briefly the generating station and plant in use at Woolwich. The boilers, three in number, are constructed for a working pressure of 120 lbs. per square inch; they are hand-stoked two-flue multitubular boilers, of the "gunboat" type. The engine and dynamo-room, which is only 42 ft. × 30 ft., will accoommdate four sets of generating plant; at present only three are erected, and the fourth set is quite ready to put down. The dynamos are H.B. 24/36 shunt wound, each giving normally 1,500 ampères at 120 volts when running at 350 revolutions per minute.

Two of the dynamos are coupled direct to Willans III. compound non-condensing engines, indicating 300 H.P. at 350 revolutions. The third is coupled to a Belliss compound closed engine, also indicating 300 H.P. at 350 revolutions.

From the dynamos the current is led through the main switchboard, and is measured by the ammeters, the total amount of electrical energy supplied being measured by the electricity meter. Pressure is continuously indicated by a volt meter connected across the distributing bars. The switching arrangements are such that all the machines may be run in parallel. Current is distributed throughout the works by means of underground cables. There is first a copper conductor consisting of strands of wire of suitable size for the current; over this is lapped jute impregnated with insulating compound; next comes a continuous lead pipe to keep out damp, and over this the wore jute. Mechanical protection is afforded by hoop steel, wound spirally, and lastly an outer coating of jute to protect the steel from rusting.

These heavy cables can only be made in lengths of 180 or 200 yds., so it is necessary to join the ends of these lengths together.

The ends of the cable are brought together through a copper sleeve, into which they are soldered ; the two halves of the jointer are then bolted together round the joint, and insulating oil is poured in through holes in the cover, which are afterward stopped by screw plugs.

Stuffing-boxes at each end keep out damp. The cables are laid straight into the ground, without any culverts or other protection than the armoring, and long experience proves that nothing could be more simple and satisfactory. Wherever a cable enters a workshop it goes first to a distributing board, fitted with a controlling switch and electricity meter ; from there it branches to the requisite number of circuits, each circuit being protected with a safety fuse.

I now come to the all-important question of cost, and will proceed to give the results of some carefully conducted tests made on the existing plant at Woolwich. In the following results the coal used in keeping steam during meal times is included, but not the coal used in lighting the boiler fires.

Number of test....	1	2	3
Date........	Feb. 23 to 28.	March 1.	March 3.
Time started......	11.45 A.M.	7 A.M.	5.57 A.M.
Time stopped......	5 P.M.	5 P.M.	5 P.M.
Total boiler hours.	46.6	10	11.033
Total engine hours.	41.78	8.567	9.617
Coal, description.. Welsh medium quality, 15s. per ton, delivered in bunkers.			
Weight used.....	27418	5488	6730
In Board of Trade units. Total output................	4899	983	1287
In Board of Trade units. Mean hourly output........	117.27	114.78	133.66
In Board of Trade units. Pounds of coal per unit....	5.596	5.584	5.234
In electrical H.P. Total H.P. hours	6567.1	1317.5	1724.6
In electrical H.P. Mean effort................	157.2	158.2	179.15
In electrical H.P. Pounds of coal per H.P. hour	4.157	4.165	3.897

Mean result, 4 lb. of coal per electrical H.P. hour.

The plant in the above tests was not working under the most favorable conditions, not being fully loaded ; when fully loaded and condensing still lower consumption may be reasonably expected. Three indicator cards were taken from No. 3 engine (Willans) on March 2, and the electrical H.P. was measured simultaneously. In the three cases we found respectively 84.2, 84.0, and 83.7 per cent. of the indicator H.P. as available electrical H.P. at the main switchboard.

The cost of an electrical H.P. hour works out as follows :

Coal. 4 lbs., at $3.75 per ton........	0.75 ct.
Wages, stokers, trimmers, engine drivers, laborers, electrical assistant (half time), laborer (one-third time), switchboard boy....	0.08
Feed water............	0.0500
Oil and Waste....................	0.0292
Removing ashes....................	0.0092
	0.9184
Cost of a Board of Trade unit..............................	1.090 ct.

In this statement of cost it is assumed that the station is in full work, three boilers and three engines each giving 240 electrical H.P. This only represents 80 per cent of the indicator H.P., and we have obtained over 84 per cent., so that the cost given above is rather overstated. Taking the cost of an electrical H.P. hour at .8 cent and working 10 hours a day for 300 days a year, each electrical H.P. at the main switchboard costs $24.00 per annum ; 70 per cent. of this is available as brake H.P. at the spot where it is used, so each brake H.P. costs $34.29 per annum.

We commonly find $48.66 given as the yearly cost of a brake H.P. Assuming this to be fair, we have still a margin of $13.98 to pay for repairs and depreciation, a far larger sum than we are ever likely to require. At present we have working eight motors of 40 brake H.P., four of 20, two of 15, three of 10, one of 8, two of 5, and two of ½ H.P., for driving ventilating fans, making a total of 479 H.P. Three more are being put down, one of 40 and two of 20, and nine more are in hand, seven being of 75 H.P., one of 40, and one of 30. We also anticipate early extensions amounting to another 350 H.P., bringing up the total to 1,504 H.P.

The maximum normal output of the generating station working at 84 per cent efficiency is 1,008 electrical H.P., or 706 brake H.P. at the motors. This may seem a small proportion of the possible total, but we believe it is sufficient to meet the ordinary loads, and extensions in the generating plant are easily arranged. Of course in some factories it might be necessary to have generating plant capable of working all shops at full load.

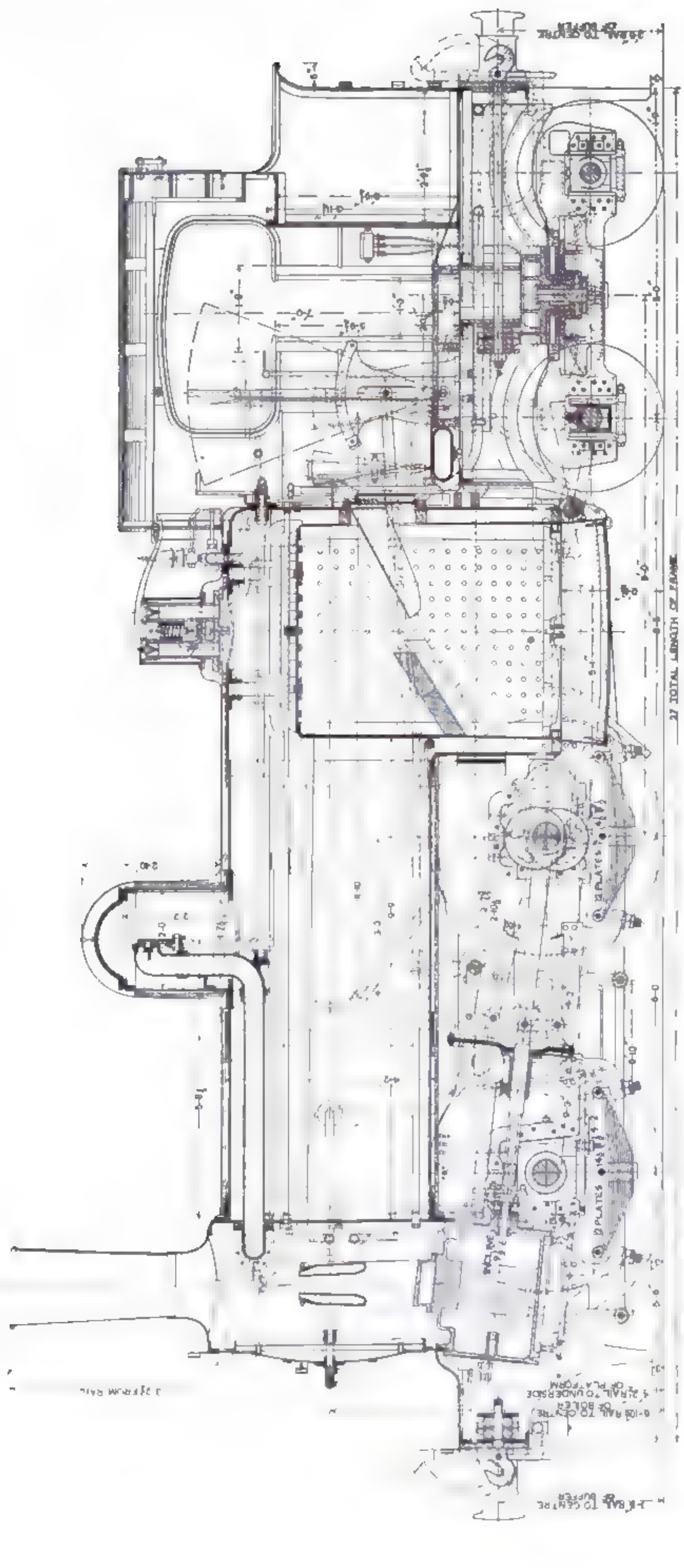
So far I have only dealt with the advantages of transmitting power electrically in large works. I believe, however, that small industries will benefit largely in the future from the establishment of central power stations in towns and cities, from which stations small manufacturers can get a supply of current at a reasonable price, and avoid the trouble of looking after a small steam or other engine. Such a state of things would be going backward in a certain sense, but it would be going back to a far happier state, for the skilled artisan would be able to take in work at his own small shop and have the satisfaction of feeling his own master, while he would not necessarily be debarred from competition with the larger works for want of power.

UNCONSIDERED USES OF WOOD.

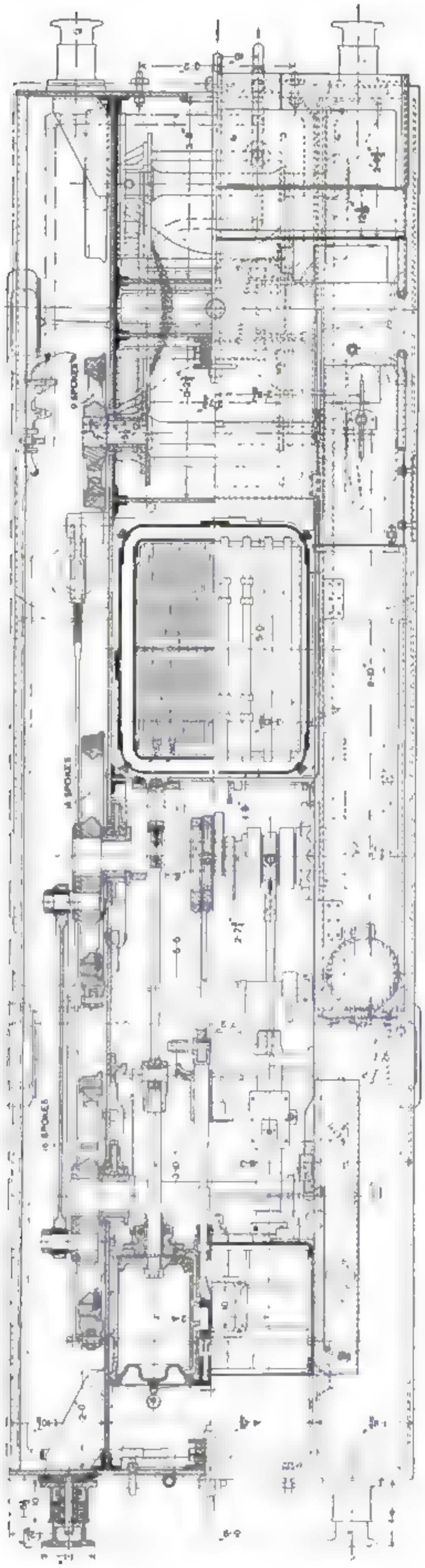
There are countless ways in which wood is being consumed, besides the larger uses for fuel, building purposes, and the like ; and that in the aggregate these unconsidered uses amount to a serious drain upon the forests, while little or nothing is done to insure a supply for future demands. The enumeration of the special uses of wood in the arts forms a very interesting chapter. One of the principal uses of the wood of the holly, dyed black, is to be substituted for ebony in the handles of metal teapots, etc., and the strong straight shoals, deprived of their bark, are made into whip handles and walking sticks. The lime-tree forms the best planks for shoemakers and glovers upon which to cut their leather, and is extensively used in the manufacture of toys and Tunbridge ware, and by the turner for pill boxes, etc. ; and the inner bark is made into ropes and matting. The sycamore furnishes wood for cheese and cider presses, mangles, etc., and when the wooden dishes and spoons were in common use they were mostly made of this wood. It is now used also in printing and bleaching works, for beetling beams, and in cast-iron foundries for making patterns. The yew is used by the turner and made into vases, snuff-boxes, and musical instruments ; and it is a common saying among the inhabitants of New Forest that a post of yew will outlast a post of iron. Where it is found in sufficient quantities to be employed for works underground, such as water pipes, pumps, etc., the yew will last longer than any other wood. Gate posts and stakes of yew are admirable to wear, and in France the wood makes the strongest of all wooden axletrees. Of the beech are made planes, screws, wooden shovels ; and common fowling-pieces and muskets are also stocked with it, and beech staves for herring barrels are not unknown. The sweet or Spanish chestnut furnishes gate and other posts, railing, and barrel staves, hop poles, and other such matters, such as strong and good charcoal, though scarcely equal to that of oak for domestic purposes, but considered superior to that of any other for forges.

Hornbeam is the best wood that can be used for cogs of wheels, excelling either the crab or the yew ; but its application in this manner is about at an end. As a fuel it stands in the highest rank, emitting much heat, burning long, and with a bright, clear flame. In charcoal it is highly prized not only for culinary purposes and the forge, but also for the manufacture of gunpowder, into which, on the Continent, it enters in large proportion.

In Russia many of the roads are formed of the trunks of the Scotch pine, trees from 6 in. to 1 ft. in diameter at the larger end being selected for the purpose. These are laid down side by side across the intended road, the thick of one alternately with the narrow end of the other, and the branches being left at the end to form a sort of hedge on each side of the road. When thus laid, the hollows are filled up with earth, and the road is finished, being analogous to the corduroy roads of North America. In Germany casks are made of larch, which is almost indestructible, and they allow of no evaporation of the spirituous particles of the wine contained in them. In Switzerland it is much used for vine crops, which are never taken up, and which see crop after crop of vines spring up, bear their fruit, and perish at their feet without showing symptoms of decay. The uninjured state in which it remains when buried in the earth or immersed in water renders it an excellent material for water-pipes, to which purpose it is largely applied in many parts of France. The butternut is esteemed for the posts and rails of rural fences in America, for troughs for the use of cattle, for corn shovels and wooden dishes. Shell-bark hickory provides baskets, whip handles, and the backbows of Windsor chairs. The pignut hickory is preferred to any other for axletrees and ax-handles. The sugar maple is used by wheelwrights for axletrees and spokes, and for lining the runners of common sleds. Dogwood is used for the handles of light tools such as mallets, small vises, etc. In the country it furnishes harrow teeth to the American farmer, and supplies the harness of horses' collars, etc. ; also lining for the runners of sledges. The mountain laurel is selected for the handles of light tools, for small screws, boxes, etc. It most resembles boxwood, and is most proper to supply its place. Bowls and trays are made of red birch, and when saplings of hickory or white oak are not to be found, hoops, particularly those of rice casks, are made of the young stocks and of branches not exceeding 1 in. in diameter. Its twigs are ex-



FOUR-WHEELED COUPLED BOGIE TANK LOCOMOTIVE ON THE LONDON & SOUTHWESTERN RAILWAY. DESIGNED BY MR. W ADAMS, LOCOMOTIVE SUPERINTENDENT.



PLAN OF FOUR-WHEELED COUPLED BOGIE TANK LOCOMOTIVE ON THE LONDON & SOUTHWESTERN RAILWAY. DESIGNED BY MR. W. ADAMS, LOCOMOTIVE SUPERINTENDENT.

clusively chosen for the brooms with which the streets and court-yards are swept. The twigs of the other species of both, being less supple and more brittle, are not proper for this use. Shoe lasts are made from birch, but they are less esteemed than those of beech.

Immense quantities of wooden shoes are made in France from the wood of the European alder, which are seasoned by fire before they are sold. The wood of the locust is substituted for box by the turners in many species of light work, such as salt cellars, sugar-bowls, candlesticks, spoons, and forks for salads, boxes, and many other trifling objects, which are carefully wrought into pleasant shapes and sold at low prices. The olive is used to form light ornamental articles, such as dressing cases, tobacco-boxes, etc. The wood of the roots, which is more agreeably marbled, is preferred, and for inlaying it is invaluable. Of persimmon turners make large screws and tinmen mallets. Also shoemakers' lasts are made of it equal to beech, and for the shafts of chaises it has been found preferable to ash, and to every species of wood except lancewood. The common European elm is used for the carriages of cannon, and for the gunwale, the blocks, etc., of ships. It is everywhere preferred by wheelwrights for the naves and fellies of wheels, and for other objects. White cedar serves many subsidiary purposes. From it are fabricated pails, washtubs, and churns of different forms. The ware is cheap, light, and neatly made, and instead of becoming dull, like that of other wood, it grows whiter and smoother by use. The hoops are made of young cedars stripped of the bark and split into two parts. The wood also supplies good charcoal. The red cedar furnishes staves, stopcocks, stakes, and is also used for coffins.

A few special applications of wood in this country are mentioned, separated into trades—namely, sieves, usually of black or water ash for the bottom and oak or hickory for the circle; whipstocks, white oak; baskets, willow, white oak, and shellbark hickory; picture frames, white pine and sweet gum; saddle-trees, red maple and sugar maple; screws of bookbinders' presses, hickory or dogwood; hatters' blocks, sour gum; corn shovels, butternut; shoe lasts, beech and black or yellow birch.—*Illustrated Carpenter and Builder.*

FOUR-WHEELED COUPLED BOGIE TANK LOCOMOTIVE.

This type of engine has been designed by Mr. W. Adams, Locomotive Superintendent of the London & Southwestern Railway, and built at the Company's works at Nine Elms, and is intended for working the lighter suburban and branch traffic of the railway.

As will be seen from the accompanying drawing, the engine has the leading and driving-wheels coupled, 4 ft. 10 in. in diameter, while the back of the engine is carried on a four-wheeled bogie of the "Adams" type, having wheels 3 ft. in diameter.

The cylinders are 17½ in. in diameter with a stroke of 24 in. The tractive force developed is accordingly

$$\frac{17\tfrac{1}{2}^2 \times 24}{58} = 126.7 \text{ lbs.}$$

for every pound of mean effective pressure on the pistons. The cut-off varies from 77 per cent. in full gear to 28 per cent. under usual running conditions.

The boiler pressure is 160 lbs. per square inch, hence the total tractive effort available is about 17,000 lbs. at starting and 11,000 lbs. under ordinary running conditions. The total weight on the coupled wheels with the engine in working order is 66,136 lbs., which, with a coefficient of adhesion of one-fourth, is sufficient to prevent slipping.

The boiler is constructed of steel plates with butt joints, the top of the fire-box casing being flush with the barrel. The mild steel plates are specified to be free from silicon, sulphur, and phosphorus, and to have a tensile strength of not less than 25 tons and not more than 30 tons per square inch with an elongation of at least 23 per cent. in 10 in. The longitudinal joints have inner and outer cover strips with zigzag double riveting. The transverse joints are made with an external weldless ring double riveted to the barrel, the ring being turned to gauge and shrunk on the barrel. The joint between smoke-box and barrel is also made in a similar way with a weldless angle ring.

The rivets, ¾ in. in diameter, are of the best Yorkshire iron closed by hydraulic pressure. They are pitched at 1¾ in.

The fire-box is of copper and contains a fire-brick arch. It is connected to the outer casing by copper stays 1 in. in diame

eter, 12 threads per inch, pitched at intervals of 3⅞ in. The roof is stayed by eight cast-steel girder stays, the four center ones being slung from the casing. The tube plate, which is ⅞ in. thick at the tubes, is stayed to the barrel by six palm stays. The foundation and fire-hole rings are of wrought iron, and the fire-bars are of cast iron.

The regulator is of cast iron 4½ in. diameter, with a main slide-valve of brass and an easing valve of cast iron.

The dome is of ½ in. boiler plate butt jointed with inner and outer strips single riveted. It is flanged to fit the barrel and double riveted to it with a ½-in. strengthening plate.

The boiler is fitted with a "Ramsbottom" duplex safety-valve.

The frames are of steel of boiler plate quality, 1 in. thick. They are connected under the cab by a strong steel casting to carry the bogie center pin and trasmit the weight to the bogie, the frames of which are of steel 1 in. thick, and stayed together by a strong steel casting which forms a slide to give transverse play to the centre pin, this being controlled by laminated plate springs.

All the wheel centers are of cast steel. One casting in 40 is tested to destruction by dropping weights in order to determine its breaking strength.

The tires are of steel supplied by Vickers & Co., of Sheffield, and are 3 in. thick on tread. They are secured to the wheels with a lip and 1⅛ in. set screws.

The axles are of steel, and are specified to have a tensile strength of not less than 32 tons per square inch, with an elongation of not less than 25 per cent. in 2 in.

The cylinders are of the twin type, being one casting, and special arrangements have been made for machining them. The steam-ports are 1⅝ in. wide and 14 in. long. The exhaust-ports are 3¼ in. wide, and the bars between the ports 1 in. wide. The slide-valves are of Stone's bronze with recesses on the working faces. The pistons are of cast iron with two cast-iron rings each, each ring being ¾ in. wide and ½ in. thick. The piston-rods are forged from the best cast steel with a breaking strength of 30 tons per square inch. They are packed with "United States" metallic packing.

The slide-bars, one to each cylinder, are of wrought iron, case-hardened, and 6 in. wide by 3 in. deep.

The cross-heads are of cast steel with cast-iron caps and rubbing pieces. The cap is secured to the main casting by ⅞ in. bolts, a liner being introduced to permit adjustment for wear.

The valve-motion is of the curved link type, and made of best Yorkshire iron, the working parts being case-hardened. The links are hung from their centers and connected at their extremities to the eccentric rods. The eccentric pulleys are in two parts, and are made of cylinder metal. They are fastened to the crank-axle by keys and set screws. The straps are of cast iron.

The engine is reversed by a lever and sector on the right-hand side of the engine. The reversing shaft is of Yorkshire iron, the levers being forged solid with the shaft. All working parts of the shaft are case-hardened.

The connecting-rods are of Yorkshire iron, and measure 3 ft. 5 in. between centers. The big ends are fitted with straps and adjustable brasses. The small ends are fitted with plain gun-metal bushes forced in by hydraulic pressure.

The coupling-rods are of Yorkshire iron forged solid and milled to an H section, and fitted with gun-metal bushes with white metal strips.

The crank-pins are of Yorkshire iron case-hardened, and are forced into their places in the wheels by hydraulic pressure and riveted over on the inside.

The crank-axle is of the very best cast steel forged solid. All four crank webs are hooped with steel bands 3½ in. × 1½ in., shrunk on. All crank-axles are supplied by Messrs. Vickers & Co.

The engines are fitted with the "Adams" patent vortex blast-pipe, which is successful in softening and utilizing the exhaust steam to obtain a good vacuum in the smoke-box, its effect being equally distributed over the tubes, the lower tubes being thus kept free and their efficiency unimpaired by becoming choked up, as is the case when an ordinary plain blast-pipe is used. Engines fitted with this form of pipe have given economical results.

The engine is fitted with a steam-brake worked in conjunction with the automatic vacuum brake on the train.

Two No. 8 injectors (Dewrance's) are fixed one on each side of the engine.

The tanks are made of best Staffordshire iron with ½ in. rivets at about 1½ in. pitch. They have a water capacity of 800 gallons.

The coal bunker has a capacity of 80 cub. ft., being equivalent to nearly 2 tons of coal.

Fifty of these engines have been constructed at the Company's Nine Elms Works, and are now running, giving great satisfaction and being remarkably free from defects in working.

The following are the principal dimensions of the engine:

	Ft.	Ins.
Cylinders:		
Diameter	1	5½
Stroke	2	
Length of ports	1	2
Width of steam ports		1⅝
" " exhaust ports		3½
Center to center of cylinders	2	4
" " " " valve spindles		3¾
" line of cylinder to valve face		11⅜
Diameter of piston-rods		3¼
Motion:		
Lap of valves		⅞
Lead of valves		⅛
Maximum travel of valves		3¾
Throw of eccentrics		5⅝
Diameter of eccentric-sheaves	1	3½
Length of cross-head slide block	1	1¼
Wheels (Cast Steel):		
Leading and driving wheels, diameter on tread	4	10
Bogie wheels, diameter on tread	3	
Thickness of tires		3
Width of tires		5½
Diameter of crank-pins for coupling-rods		3¾
Length of bearing-pins " "		4$\frac{1}{16}$
Diameter of cranks		7
Length " "		4
Axles (Steel). Bogie:		
Diameter of wheel-seat		7
Length " "		5⅞
Diameter of journals		5½
Length " "		10
Diameter at center		5¼
Centers of journals	3	7
Axles (Steel). Leading and Driving:		
Diameter of wheel-seat		8½
Length " "		6⅞
Diameter of journals		7
Length " "		7½
Diameter at center (leading)		6¾
" " " (driving)		7
Centers of journals	3	11½
Frames (Steel):		
From front end to center of leading axle	5	6
From center of leading axle to center of driving axle	6	10
" " " driving-axle to center of bogie	11	
" " " bogie to back end	4	3
Total length of frames	27	7
Thickness " "		1
Total length of engine over buffers	30	8½
Width over platform	8	3
Boiler (Steel):		
Height of center from rail	6	10½
Length of barrel	9	5
" between tube-plates	9	9
" over all	14	5
Diameter of barrel (outside)	4	2
Thickness of plates		½
" " smoke-box tube-plates		¾
Firebox Casing (Steel):		
Length outside	5	
Width outside at bottom	3	10½
Depth below center line of boiler	4	9
Thickness of crown and side plates		⅝
" " throat plate		$\frac{9}{16}$
" " back "		$\frac{9}{16}$
Centers of stays (copper)		3⅞
Diameter of stays (copper)		1
Pitch of rivets		1⅞
Diameter of rivets		¾
Firebox (Copper):		
Length at bottom (inside)	4	3⅞
" " top "	4	2$\frac{9}{16}$
Width at bottom "	3	2½
" " top "	3	5½
Depth (inside)	5	5
Center of boiler to top of box (inside)		8
Thickness of crown and side plates		½
" " tube-plate at top		⅞
" " " " " bottom		½
" " back plate		½
Tubes (Steel):		
Number		201
Diameter outside		1¾
Height:		
Top of chimney to rail	13	2¾

Tanks:

Contents of two tanks	800 gals.

Heating Surface:

Tubes	897.76 sq. ft.
Firebox	89.75 "
Total	987.51 sq. ft.
Grate area	13.83 sq. ft.
Flue area (201 tubes)	2.24 "
Chimney area	1.23 "
Cylinder area	1.67 "
Ratio of sectional area of chimney to grate area	1 : 11.27
" " grate surface to heating surface	1 : 71.4
" " flue area through tubes to grate area	1 : 6.17
" " cylinder area to grate area	1 : 8.28

Weight of Engine empty:	Tons.	Cwts.	Qrs.
Leading	12	8	2
Driving	13	8	2
Bogie	11	13	0
Total	37	10	0

Weight of Engine in Working Order:	Tons.	Cwts.	Qrs.
Leading	14	10	2
Driving	15	0	0
Bogie	15	1	0
Total	44	11	2

Weight of Engine:

Per foot run	1.45 tons.

IRON AND STEEL WIRE.*

By Joseph Phillips Bedson.

That wire was known to the ancients there can be no doubt, for we read in Exodus 39 : 3, "And they did beat the gold into thin plates, and cut it into wires, to work it in the blue, and in the purple, and in the scarlet, and in the fine linen, with cunning work," in making the sacerdotal dress of Aaron, the High Priest of Israel; while wire, probably of similar style, it is recorded, has been discovered dating as far back as 1700 B.C. In the Kensington Museum there is a specimen of wire made by the Ninevites some 800 years B.C.; but all this wire was not produced as at the present time, the practice being to beat the metal into finely-hammered sheets, and then cut it up into fine strips or threads, and, as far as I can gather, this must have been the mode until toward the end of the fourteenth century. In the "History of Augsburg," dated 1351, and in that of Nuremberg, 1360, the metal-workers who made wire by means of the hammer are called "wiresmiths;" but in these works the term "wire-drawer" (*drahtzieher*) also occurs, from which one would infer that the draw-plate had been invented, but had not entirely superseded the ancient method. From these histories one is inclined to the belief that it was in Germany that wire-drawing was first carried on, after which it extended to France; for we find that at the end of the fifteenth century the invention of wire-drawing is ascribed to one Richard Archal, and iron wire in that country is called "fil d'Archal" and also "fil de Richard."

It is stated that wire was manufactured by hand in England until the year 1565, when a Saxon, Christopher Shultz, in company with some other foreigners, came to this country, under the permission granted by Queen Elizabeth to strangers, to dig for metallic ores, and introduced the drawing-plate. Previous to this the supply of iron wire, together with the combs employed by the wool-combers, was chiefly obtained from abroad. In the reign of Charles I. the wire-drawers of this country suffered as much by the competition of our German neighbors as we do to-day, for in a proclamation of this period it is stated that "iron wire is a manufacture long practised in this realm, whereby many thousands of our subjects have long been employed; and that English wire is made of the toughest and best Osmond iron, a native commodity of this kingdom, and is much better than what comes from foreign parts, especially for making wool-cards, without which no good cloth can be made. And whereas complaints have been made by the wire-drawers of this kingdom, that by reason of the great quantities of foreign iron wire lately imported, our said subjects cannot be set on work; therefore we prohibit the importation of foreign iron wire and wool cards made thereof, as also hooks and eyes, and other manufactures made of foreign wire. Neither shall any translate and trim up any old wool-cards, nor sell the same at home or abroad." From this it will be seen that the industry was of some importance even in Charles's time, and I doubt not but what there are some wire-drawers to-day who secretly would like some friendly power to prohibit the importation of foreign rods and wire into this country.

The Forest of Dean, which supplied good charcoal iron, was long the seat of the wire-drawing trade, where the metal was made in rods about ½ in. square, about 3 lbs. to 4 lbs. in weight, from which the wire was drawn down into a circular form the required size. The two small samples herewith are actually pieces of charcoal iron rod strips which were manufactured at the Tintern Abbey works for wire-drawing purposes. I believe these works were originally started about 1575 by four families who came from Germany, and they first hammered (called "tilting") the charcoal iron into these ½ in. square rods, which afterward they drew through draw-plates, but not on to blocks. This was effected by means of a long pole, which had a reciprocating motion, actuated by a water-wheel, and in this way worked backward and forward. In the forward stroke it drew the rod and wire through the plate, and on its return stroke, both of which were very slow, the workman sat and coiled up the length drawn by hand into a ring, and thus continued until the whole piece was drawn. The annealing was done in a kiln or brick oven, where the wire was heated to redness and allowed to cool naturally. This formed a lot of scale, which had to be removed by hammering, and then scoured in a barrel filled with wire and gravel and caused to rotate by water power, half immersed in water, for about 12 hours, when the wire was taken out, coated with flour lees, and ready for drawing on. The output of these works was about 26 cwt. per week.

According to Mr. J. Bucknall Smith, in his book on "Wire, its Manufacture and Uses," the first mechanical wire-mill proper in England was erected in 1663 at Sheen, near Richmond, Surrey, and from this date the industry maintained a substantial footing, and established a series of progressive developments, from which I should gather that the revolving block must have been in use.

In the seventeenth century the wire trade seems to have followed the woolen cloth manufacture into Yorkshire, and there, in the Halifax and Brughouse District, the largest quantity of card wire is manufactured to-day.

In the eighteenth century Birmingham began to figure prominently in the wire trade, a large quantity of wire being manufactured there; but at the beginning of this century Warrington began to take the lead as a large producer, and at the same time Manchester, with only one firm, kept well to the front in improvements, and, in fact, took the lead in iron telegraph wire of high quality.

So little had the wire trade progressed during the eighteenth century to the beginning of this, I well remember my father describing to me how his father, who was a Birmingham man and highly skilled in the drawing of steel for music and needle wire, drew a piece of bar steel 1 in. in diameter, 9 in. long, down to a wire as fine as the human hair, to exhibit before George IV. on his visit to Birmingham to see specimens and samples of the various trades carried on in that town, the mode being almost identical with the earliest practice. The bar was forged down to ¼ in. round, and then drawn through a draw-plate and annealed, as the nature of the material required, until it had assumed the finest possible size. I should add here that on the wire trade being taken up at Warrington an improvement was made over the mode as carried out in Birmingham. In the latter place the wire-drawer did all the work pertaining to his business—*i.e.*, he cleaned his rods, drew his wire, annealed it, and cleaned it again and drew it as required, and made it up ready to go out to the consumer. While it was a good school to learn in, it naturally followed that the wire was not as carefully handled to present a nice appearance to the eye. In Warrington this system was discarded, and the work subdivided between cleaners, annealers, drawers, and warehousemen, and I think it is to the credit of Mr. William Longshaw, of Warrington, who had the management of one of the oldest houses in the wire trade in that town, to have been the first to see the importance of this, and to put it into actual practice. Indeed, so much was it appreciated, that the wire not only was well received, but as a "market wire" secured a better price in the early days. Of course others soon followed in the same track.

I will now describe the *modus operandi* of wire-drawing, which is as follows: Ordinarily a wire rod, either No. 5 or No. 6, .212 in. and .192 in. respectively, is taken from the rolling-mill and placed in a cistern of hydrochloric or dilute sulphuric acid, and is allowed to rest there until the coat of oxide, which has formed in the hot rolling, is completely removed. It is then taken out and well washed with clean

* Paper read before the Iron and Steel Institute.

water to remove all trace of acid and dirt, and then coated with a mixture of lime and water, which is allowed to dry on. After this, the cleaning operation, the end of the rod is pointed, usually by mechanical means, and is handed to the wire-drawer for drawing to the size required. Previous to pointing the rod mechanically it was done by smiths or pointers in a smith's fire. The coil of rod was opened and the end heated in a fire under blast, and then, when heated sufficiently, the point was made on an anvil by the smith with his hammer. This, as can be readily seen, was feasible as long as the coils were only 20 lbs. or 30 lbs. each, but when they got to 150 lbs. and even 2¼ cwt., it would be more difficult. The pointing machine, a modification of an American needle-pointing machine, does this very easily, and, whereas by hand the cost was about 1*s.* 10*d.* (44 cents) per ton, this machine does it for under 2*d.* (4 cents). The machine consists of a pair of rotating hammers running at 120 revolutions per minute, and capable of giving three times that number of blows in the same time, in doing which it forms the point described. The drawer is provided with a block which revolves at will on a vertical spindle, driven by a horizontal shaft through a pair of bevel wheels under the bench or table upon which the drawer works. On this bench-top is a tool-holder which holds the draw-plate, which plate contains many conically shaped holes of suitable sizes, and at their small end smaller than the rod which is to be drawn. These holes are roughly "pricked" in the plate by an experienced smith, and then the wire-drawer finally prepares and shapes the holes and their exact size, when cold, by taper punches. In this is the art of the wire-drawer coupled with the grinding of his punches suitably and always round and cylindrical. The size desired being decided upon, the drawer passes the aforementioned taper point of the rod through the plate, seizes the same with a pair of stout tongs, which are operated as required by power, and pulls a sufficient length through the draw-plate to enable him to secure this end to the vice which is mounted at the top of the block. This accomplished, the block is set in motion, and the whole of the piece is eventually wound on to the block, the wire-drawer taking great care that as the rod passes through the plate plenty of tallow or other lubricant is applied to the rod at the point of admission to the conical hole of the plate, otherwise the piece would "scrap" and eventually "pull the hole out," and thus deform it from its original size. As the wire is reduced in size by continual drawing, the material becomes more dense and hard, so that as the work proceeds annealing has to be resorted to to render the material suitably ductile once more. This is effected by placing the coils of wire in vertical cylinders, which, when filled with such wire, are hermetically sealed and heated to redness, and then allowed to cool slowly, and then the same operation of cleaning for drawing is gone through as before described. This obtains in all wire-drawing except as regards the draw-plates in very fine wire, in which jeweled dies, such as diamonds, rubies, etc., are substituted for the metal plate.

The first departure in wire-drawing, the date of which I am unable to say, was the adoption of the wince or block which revolved vertically on a spindle operated by hand. The next step was the application of power to this, water being the prime mover.

Iron wire was first drawn from square strips cut out of plates, until Cort's invention enabled round rods to be rolled, and even then these could only be produced of 12 lbs. to 14 lbs. each.

On June 12, 1837, Cooke and Wheatstone's first patent for an electric telegraph was sealed, and the adoption of this invention eventually created a great demand for wire, which began to make itself felt in the later years of the forties. Quickly following the national benefit of telegraphing naturally came the international desire, which resulted in the laying of the submarine cable between Dover and Calais in 1851. Two points of wire-drawing interest are attached to the drawing of the iron wire for this cable, the one being the long lengths of wire rods used—namely, No. 2 full rods of 30 lbs. each, and the second, I believe, being the first time rods were drawn through two holes without any intermediate annealing. In connection with the first point the wire drawers formed a deputation to ask for an advanced price for drawing these "long" pieces, and were almost successful in their application, had not Mr. George Bedson, who had the management of the works, and whose practical knowledge showed him how ridiculous the demand was, stepped in and demonstrated the absurdity of the request. It was also on the second point that Mr. Bedson's knowledge of the material to be dealt with caused this important departure to be made. With further reference to the first point, again, in 1865 or thereabouts, did the wire-drawers raise the question of extra price for drawing long rods when Mr. Bedson was rolling pieces of 112 lbs., and, indeed, they afterward went further and declared that to them was due the success of the continuous rolling mill, as they were able to draw the extra long pieces.

The first cable between Dover and Calais and several others connecting this island with our sister isle and also the continent proving equally successful, a desire to span the Atlantic was speedily gratified, for in 1858 the first cable was laid, and to quote Mr. W. H. Preece, F.R.S., etc., Chief Electrician to the Post Office Telegraphs and President of the Institution of Electrical Engineers, in his inaugural address to that Institution: "The first attempt was made in August, 1857, by H.M.S. *Agamemnon* and the United States frigate *Niagara*; but after paying out about 380 miles from the Valentia end the cable broke, and the expedition was abandoned until 1858, when the same two ships, this time commencing in mid-Atlantic and steaming in opposite directions, succeeded in laying the cable; but after 732 messages had been sent through, it again failed in October, 1858. Several unsuccessful attempts were made to pick it up, and the Atlantic scheme remained in abeyance until 1865, when a heavier cable was successfully laid, being the commencement of the present Anglo-American Company's system with its four cables now working across the Atlantic. There are now 11 cables bridging the Atlantic Ocean, 10 of which are duplexed.

Mr. George Bedson, seeing the importance of the telegraph-wire trade, tried to induce the people he was with at Warrington to launch out into this particular line; but failing in this, he took charge of a small wire-mill in Manchester, and it was here it fell to his lot to undertake the drawing of the iron wire for the Dover and Calais submarine cable, as well as the production of half the wire for the first Atlantic cable. The size of wire required for the Atlantic cable was exceedingly small, not at all on the same lines as the present cables, so that the drawing of this wire not only taxed the Manchester firm to its utmost, but several of the Yorkshire wire-drawers had to finish large quantities, which was done under Mr. Bedson's supervision. I do not think I can do better than give his own description of this wire as written by himself at the time, and which I accidentally found just recently among his papers. It is as follows:

"Description of the manufacture of No. 22 best charcoal iron wire (commencing with pig iron, and through the different stages as they occur, and apply to the wire supplied for the Atlantic submarine telegraph cable). A fine quality of pig iron having been selected, it is refined, and while in a fluid state is run into a plate of about 2¼ in. thick. It is then broken up and worked in a charcoal fire into lumps of about 1¼ cwt. each. These lumps are shingled or hammered into blooms of about 4 in. square. The blooms are then heated, and after passing through a set of rolls, say, eight or nine times, they are reduced into bars of about 12 ft. to 14 ft. long and 1¼ in. thick. These bars are then cut into lengths of about 2 ft. each, and are called billets. These billets are then heated and passed through a train of rolls about 12 times, reducing them to No. 4 wire gauge, or a little less than ¼ in. in diameter. As these rods come from the rolls the last time through they are wound into coils 2 ft. 4 in. to 2 ft. 6 in. in diameter, and are now ready for the wire-drawer. These rods are pointed and then cleaned in dilute sulphuric acid, and when dried are drawn to No. 7 wire gauge, which represents $\frac{3}{16}$ in. in diameter. No. 7 wire is then annealed, and after being again cleaned is passed through the draw-plates twice, thus reducing it to No. 11 or ⅛ in. in diameter. The annealing and cleaning process is again employed, and the wire passed twice through the draw-plates and reduced to No. 14, or $\frac{1}{13}$ in. in diameter. The annealing and cleaning process is here again used for the last time; the wire being now passed through the draw-plates seven times, is finally reduced to No. 22, or rather less than $\frac{1}{35}$ in. in diameter, it being 61 times its original length when in No. 4 rods. The quantity of wire required for this order was 950 tons, and it took 1,200 tons of wire rods to produce this quantity of finished material." The celebration of laying up this quantity of wire into cable took place on June 10, 1857.

Wire for telegraph and some fencing purposes has to be galvanized, as it is technically termed, but, more accurately speaking, coated with a thin film of zinc. This was effected up to 1860 in the following manner: The wire, after being drawn to the required size, is annealed in the annealing pot and afterward cleaned, both operations being done as before described; but instead of being dried, it is taken to the swifts or reels, upon which it is placed to be unwound in a wet state. The wire is then unwound and passed, first, through a shallow bath of dilute hydrochloric acid, to finally clean and prepare the surface of the wire to readily take the zinc, and thence through a bath of molten zinc, through which it passes and emerges at the opposite end through a bed of sand, which

regulates the quantity of zinc taken up, about .0015 of an inch a side for an average size of, say, No. 8, and thence to the blocks upon which the galvanized wire is finally wound. Wire treated in this manner often gave trouble, as it would sometimes become rotten through weak acid being present in the wet coils as they lay on the swifts before winding off, and then, again, the wire missed taking up the molten metal, as the surface had got dry and a thin film of oxide had formed, and many other sources of trouble, all of which tended to spread the opinion that all galvanized wire was exceedingly brittle and rotten, owing to the process it went through. In order, therefore, to meet these difficulties, Mr. Bedson invented, in 1860, his continuous galvanizing process, by which these difficulties were all overcome, and from which most excellent results were obtained. The *modus operandi* was as follows: The wire after having been drawn was taken direct in its bright state to the swifts, thence run off through a long furnace in which the wire was annealed, or even tempered if necessary; thence through a bath of hydrochloric acid, which cleaned the wire and threw down the oxide formed in annealing, and thence through the bath of molten zinc to the blocks; and this process has been the one gradually adopted, both in Europe and the United States of America, with success. During the life of the patent several firms were licensed to use the process, while some of our Continental competitors adopted it without grant of license, or even saying "by your leave."

About this time Mr. Bedson was induced to take the management of the Bradford Iron Works, Manchester, which the people with whom he was had acquired. At these works there were about 20 puddling furnaces, two metal helves, forge trains, and two wire-rod mills, and it was here that his attention was drawn to the shortness of the rods rolled, and the necessity of remedying the evil, if he were able, in order to produce such increased individual weights as had never been attempted before. The advantage of longer pieces was thus very forcibly pressed upon him, for the jointing and welding for telegraph lines was not only unsatisfactory, but dangerous. At last, in 1862, he patented his continuous rod-rolling mill, by which the billet, about $1\frac{1}{16}$ in. square and of 100 lbs. weight, was drawn from a Siemens gas furnace placed immediately in front of the first roll of the mill, and from this passed on through each successive pair of rolls, 16 in number, placed in line, and each running at an accelerated speed, according to the draft of each roll. This mill was very difficult to perfect, but by degrees it became a most perfect machine, and its capacity grew up to 20 tons of No. 5 iron wire rods in a turn of 10 hours.

I think I cannot do better here than quote from a report by Mr. Abram S. Hewitt, United States Commissioner to the Universal Exposition at Paris, 1867, on "The Production of Iron and Steel in its Economic and Social Relations:"

"The most remarkable specimen of rolling was in the English department in the shape of a coil of No. 3 wire rods weighing 281 lbs., in length 350 yds., rolled from a single billet. Also a coil of No. 8 wire weighing 200 lbs., 900 yds. in length, and a coil of No. 11 wire weighing 95 lbs., in length 790 yds. These wonderful specimens of wire were not, however, produced in an ordinary mill, but were rolled in a machine invented by Mr. George Bedson, the Manager of the Bradford Iron Works in Manchester. This machine consists of rolls in 13 pairs,* placed one behind the other, instead of side by side, as usual, with guides connecting the successive pairs of rolls, and revolving at such relative rates of speed that the billet being rolled receives the compressing action of the rolls at the same time. The billet is fed from a long feeding furnace at one end of the train of rolls, being charged at the end of the furnace furthest from the train. A Siemens generator is used to supply the furnace with gas, so as to insure a uniform heat. The average product of the train is 11 tons per day, and the weight of the billets usually rolled is from 80 lbs. to 100 lbs. A comparison of the work for six months with two old-fashioned trains also running in the same works shows that the waste is reduced from $10\frac{1}{4}$ per cent. to $6\frac{3}{10}$ per cent., and that the consumption of coal is reduced from 14 cwt., 3 qr., 25 lbs. to 8 cwt., 18 lbs. per ton, most of which saving is doubtless due to the use of the Siemens furnace and not to the train, the advantages of the latter consisting in an increase of product of nearly one-half, in the increased weight of the billets rolled, and in the economy of the labor employed. A personal visit was made to the Bradford Iron Works to see the operation of this ingenious and successful machine. It appears to be all that could be desired, and the action of the rolls upon the iron unquestionably produces a sounder and better rod than when worked by the old process, and this is due doubtless to the higher and more uniform heat at which the rod is finished.

"In the use of wire for telegraphic purposes, for wire suspension bridges, and for cables and ropes, the superior value of long lengths is undeniable. Bedson's machine has, therefore, the double merit of producing a better article at a lower cost than has hitherto been obtained; and it is a matter of regret to those who have become familiar with its novelty, and its merits, that it received only the recognition of a silver medal, when it so justly deserved the highest prize."

On this mill Mr. Bedson successfully rolled in iron No. 8 rods which were drawn in one hole to No. 9, in which size there was at one time a great demand for telegraph wire. Three of these mills were erected at the Bradford Iron Works, and there have run very successfully, on which rods can be rolled up to almost any weight; in fact, an iron wire rod has been rolled up to 1 ton weight. The only drawback to this mill was that it would not roll a common iron wire rod, and therefore its production was kept on telegraph wire and the best qualities of fencing wire, which had to pass a high specification. All the iron for it was, therefore, boxed-piled, having four square puddled billets in the center and four flats outside of either a best best puddled iron, or top and bottom of charcoal with sides of best best puddled iron, or charcoal all around. These were then known in the telegraphic wire trades as B. B., E. B. B., or four-sided charcoal, and out of one or other of these three grades the greatest telegraphic enterprises were constructed all over the world, and readily claimed for themselves a pre-eminence, owing to their great lengths of single pieces and their uniformity of quality. This continuous rolling-mill spurred on other rod makers in the direction of long lengths, but I believe throughout this mill stood at the head as the mill for a high-class quality of iron wire in longer lengths than was possible on any other system. It was with the aid of these inventions that Mr. Bedson, with his ability, skill, and inventive genius, raised the undertaking of which he had the general management from the smallest to the greatest eminence as telegraph-wire manufacturers, and it was particularly gratifying to him when Mr. Preece, in his paper on "Electrical Conductors," read before the Institution of Civil Engineers, on December 23, 1883, in referring to what Mr. Bedson had done, said: "I would mention how much telegraph engineers are indebted for the modern improvements in telegraph wire to the various inventions of this gentleman."

I should like to point out here that, in a paper recently read before the Institution of Civil Engineers by Mr. John Rigby, M.A., Superintendent of the Royal Small Arms Factory, Enfield, the continuous rolling-mill now in use at Enfield for rolling gun barrels at one heat out of a bar $1\frac{3}{8}$ in. in diameter, 1 ft. $8\frac{1}{4}$ in. long, therein described, was an almost exact copy of the first continuous wire rod-rolling mill, and I well remember some of the officials from Enfield coming over to Manchester to see this rod-mill in operation before they had constructed the one for Enfield.

About the year 1870 a change in the iron wire trade began to manifest itself, and that was the introduction of Bessemer metal. Although at first its regularity of carbon was not all that could be desired, and there were many failures, it gradually replaced iron where simply mechanical results were alone required. The introduction of this metal then enabled the wire rod-rollers to improve their plants, and thereby increase their lengths of rods, for the metal, being thoroughly homogeneous and capable of rolling at a lower heat, the difficulties which obtained in the rolling of iron no longer existed, and thus, where they were handicapped in iron, they were free in the rolling of steel, their success being due entirely to the character of the metal. The outcome of this was a considerable improvement in wire-rod mills.

At the period immediately preceding the invention of the continuous rod-rolling mill, a rod-rolling train consisted of a line of rolls three high, excepting the last or finishing pair, and men were placed on either side of the rolls to catch and stick in the rod as required, from the bolting-down rolls at the thick end to the finishing pair at the other. In the smaller sections, where the length had increased, loops were formed, and this involved the employment of lads to "hook" and keep these loops from getting entangled, which otherwise they readily would do. It was from this mill that many modifications and improvements were perfected to enable longer lengths and larger quantities to be rolled, and when to the mill a separate roughing mill was attached, driven at a low speed, and the older one at a higher speed, making what is commonly known in the rod trade as a "Belgian mill," we have the model of the generally adopted mill in this country. Many improvements as to economy in the use of labor have been introduced, notably repeaters, which guide the rod on the back of the rolls to the next pair automatically, thus sav-

* At Mr. Hewitt's visit, the mill was rolling larger sections, and therefore required a less number of rolls, hence 13.

ing a catcher and sticker in. An exception to this general adoption of the Belgian mill is found in Mr. John Bleckly's, of Warrington, who in 1872 patented improvements in wire rod-mills. For the description of this I am again indebted to Mr. J. Bucknall Smith's before-mentioned work. "According to this arrangement the rolls are superimposed so that a bar or rod passed through the first or top set is turned backward by the curved passage, so as to be automatically fed into the lower set. The working parts are suitably carried by the framing, while the proper relative position of the rolls may be adjusted by screw devices. A 'rod train' would be composed of a series of such rolls driven at increasing speeds through the intervention of suitable spur-gearing, in order to promptly take up the slack caused by the continually increasing lengths of the rods as they are diminished in thickness," and, according to my authority above mentioned, it "is capable of rolling from 370 to 400 tons of No. 5 gauge rods per week."

As an interesting example of the increase of production in rod-mills, the following will demonstrate the fact better than anything I can think of. In the old mills a boy at the reel could wind up easily all the rods rolled, the reel being on the same shaft as the cranked handle. In the first continuous rod-mill the quantity turned out increased, and so the reel had to be made with the handle to give one revolution to two of the reel, requiring at the same time increased power, so that a man had to be employed in lieu of the boy, and the product of the mill so increased that eventually, in 1870, the man had to be replaced with a pair of small engines running direct on the reel shaft, and worked by a boy at any required speed to take up the rod as quickly as it is rolled. In some places belts are used, but, as will be further explained, automatic reels are universally adopted in all the modern mills in the United States of America.

The use of Bessemer gradually grew to very large proportions up to 1884, when it received a very rude check, from which it has never recovered, by the introduction of basic Bessemer of Thomas and Gilchrist's patents. If there ever were a new system which revolutionized a trade, it was the introduction of basic metal for the wire trade, and further, if there ever were an old adage which had the lie given to it, it was the one that "you could not make a silk purse out of a sow's ear." To make myself more clear in my meaning, in our puddled iron days we could take any of the common ores which were made into pigs for puddling for wire purposes, and nothing but the poorest results were obtainable; nay, further, the wire rods would hardly stand drawing. Even go further and take the highest cold blast metal suitable for puddling made in this country, and the results were poor in comparison to what can be obtained from basic metal, and at fully half the cost. But now in basic metal these very same ores give the finest drawing material which was ever known, and can only be approached by the highest class of charcoal Bessemer metal as made in Sweden. To the inventors of this metal the wire-drawers of the world—*i.e.*, this country and Europe, as the United States are only users of the acid Bessemer, to any great extent for their wire trade are greatly indebted. I will not say how much, lest the makers should put up the prices; but, to put it in another light, I should not like to go back to a wire-mill drawing puddled iron wire rods. In fact, I question very much whether 25 per cent. of the workmen would be able to obtain a living thereby, at least not until they had discovered the peculiarity of this tender material.

In wire-drawing very few improvements have been made to the wire block. Mr. Bedson, early in the fifties, was the first to introduce the long pulling-in motion at one "ratch;" the old-fashioned plan being to pull in by the aid of a cam and lever attached to the pulling-in tongs at short "ratches," and as at each "ratch" the tongs had to take a fresh hold on the wire, they marked it and caused it to be cut off, thus involving waste, and this over short pieces of 15 lbs. to 20 lbs. was considerable. The long "pulling-in" had the great advantage of only taking hold of the wire once, and that at its end, which only involved a waste of 6 in., as against 24 in. to 30 in. in the older plan.

Mr. Edwin Woods, of Warrington, introduced, in 1872, a system of continuous drawing by a machine for drawing four holes at one operation, but it never achieved an extensive application or adoption.

For card-wire purposes improvements in drawing have been made in late years, for in the early part of 1886 I reported upon some labor-saving machines of the late S. H. Byrne's (of Brighouse, Yorkshire) invention, where 8, 10 and even 12 holes were being drawn at one operation. After experiments extending over a number of years Mr. Byrne took out his first patent in January, 1884, and from what I saw of the system I should think it highly successful. He was, I believe, the first in the field in this direction, and naturally he very soon had followers, by whom to-day large quantities of fine wire are drawn on this and similar systems.

Up to this point I have only touched upon the iron and steel wire trade, and although there are many other points that could be drawn in, I must leave them unnoticed, for, only being asked for a short paper, I am afraid of trespassing upon your good nature. However, I must briefly draw your attention to what may be termed the hard steel wire trade, where steel of carbons ranging from .7 upward is so manipulated that it will stand strains up to 120 tons per square inch, with torsional tests equally surprising. Such high-strained wire will not only stand 40 twists in 8 in. for No. 14 (.08 in. in diameter), but will allow of winding and unwinding upon its own diameter three or four times over, and this is the practice for the best patent steel for wire ropes for winding and haulage purposes.

I believe it is to Mr. Horsfall, of Birmingham, in 1854, that the credit of first attempting to harden and temper cast-steel wire is due; but it is to the late Mr. William Smith, of Warrington, that the secret of this "patent" wire process of to-day is due, and he worked for many years on these lines almost unapproached by any other makers in the land or even in the world; in fact, his firm practically had a monopoly. However, the secret leaked out, and is now possessed by various makers in this country, who are able to produce this very high-class wire.

As regards the Continent, Germany is the great wire-producing country, but beyond what has been done in this country in the way of improvements and developments in wire manufacture little can be said, except with regard to the rod-mill patented by Mr. Boecker, of Schalke, which consists of two trains of rolls placed parallel with each other, and speeded with such suitable gearing to take up the increased length of the rod as it passes from one set of rolls to the opposite parallel pair. This mill is doing excellent work at the present time, and is practically the only novelty in the wire trade in Germany that I know of.

As to the development of the manufacture of iron and steel wire in the United States of America and its early history, naturally more definite information is obtainable; and while in wire-drawing nothing new has been introduced, wire-rod rolling has been developed and perfected to a far greater extent than in any other country in the world. This has been very fully set forth by my friend, Mr. F. H. Daniels, of Worcester, Mass., in his paper on "Rod-Rolling Mills and their Development in America," read before the Mechanical Engineering Section of the World's Engineering Congress, Chicago, Ill., U. S. A., August, 1893.

Wire-drawing was introduced into the United States about 1666, and was one of the early industries taken up by the New World. Its use was very similar to that in this country, and it had to depend upon the slit rods very much in the same way as we had, and as previously described. This system of producing wire rods remained in vogue, without material advancement, until between 1830 and 1860. One of the first improvements, if not the first, was made at Fall River, where a rod-mill was built by the Fall River Iron Works Company. The original mill was erected in 1839, but was destroyed by fire and rebuilt in 1848. The output of the original mill was about 3 tons a turn of 1-in. rods weighing about 10 lbs. each. After the mill was rebuilt the billet was increased to 25 lbs., and rods were rolled as small as $\frac{3}{16}$ in. in diameter, giving 5 to 8 tons per turn, according to the size of the rod rolled. One of the best mills of this type running up to 1860 was erected by Ichabod and Charles Washburn, at Quinsigamond, Worcester, Mass., which could produce 9 tons of No. 4 rods of 20 lbs. to 30 lbs. pieces in one turn, and this was considered a very remarkable output.

Until 1860 looping mills were unknown, the billets being passed through the rolls back and forward, and this accounts for the light weight of billets used. The demand for longer lengths now stirred up wire-rod rollers, as the telegraph and suspension bridge engineers were calling for material with less welds and joints, and early in the sixties Mr. Ichabod Washburn (quoting from Mr. Daniels's paper), "during a visit to England made the acquaintance of Mr. George Bedson, of Manchester. Messrs. Washburn and Bedson afterward became warm friends, and an extensive correspondence and exchange of ideas regarding wire-making passed between them." It is with no ordinary feeling of pleasure and gratification to me, as the son of the late George Bedson, to hear of him being referred to at the World's Engineering Congress at Chicago, about nine years after his death, in such high terms by Mr. Daniels in the paper referred to, when he says that "Bedson was without doubt the best-informed and most skillful wire

and rod expert in Europe. Mr. Washburn was informed by Mr. Bedson from time to time regarding his experiments in the direction of rolling wire rods continuously, and he became very enthusiastic regarding the possibility in this direction. . . . Mr. Washburn decided that the Bedson mill would be of great advantage to his company, and accordingly in the fall of 1869 one of these continuous rod-wire rolling-mills was erected at the Grove Street Works, Worcester, Mass." Mr. Bedson, therefore, has the double credit of having reduced the idea of continuously rolling rods both in England and America to a successful issue. This mill was built in England and worked by English workmen, but in the hands of Mr. C. H. Morgan, and latterly of Mr. F. H. Daniels, both of Worcester, Mass., it has received enormous developments, and mills designed on the continuous system by both these gentlemen have been constructed to turn out as much as 2,000 to 2,500 tons of wire rods in a week.

As in England and Germany, the old-fashioned rod-mill was altered on to the Belgian type, as previously described, and out of this system my friend, Mr. William Garrett, designed and perfected his patent rod-mill. It consists of a roughing mill, which takes a 4-in. bloom, an intermediate mill, and a finishing train of rolls divided into two parts, the second half running at an accelerated speed to the first half. Out of this mill he has obtained wonderful results, and in the one he erected at Joliet he produced upward of 150 tons of No. 4 wire rods in 10 hours, and the rods weigh about 150 lbs. each. These large products have been made possible chiefly by the use of the automatic reel placed at the delivery end, and which winds up the rod immediately it is rolled, thus preventing all slack or accumulation, which would otherwise snarl and both spoil and stop progress.

These automatic reels were experimented upon in 1879, and on February 24, 1880, letters patent were granted to Mr. C. H. Morgan and Mr. F. H. Daniels, of Worcester, Mass., and I think to them is due the credit of working this new system out to a successful issue. All the large rod-rollers in America have their special reeling apparatus, but they are practically modifications of the principles enunciated at the outset by Messrs. Morgan and Daniels.

The rod-rolling capacity of the United States is estimated as follows:

	Gross Tons.
Garrett system, running at maximum capacity......	650,000
Continuous system, running at maximum capacity...	250,000
Other forms of mills, running at maximum capacity.	100,000
	1,000,000

It will naturally be asked where all this material goes, and when I can account for almost one-half of its going in two articles, others will suggest themselves to fill up the balance. One of the two items is barb wire, and it was first made in the fall of 1873 at De Kalb, Ill., by Mr. J. F. Glidden. In 1874 the output was 5 tons, and now the present yearly production is 200,000 tons. The second item is wire nails, the use of which was scarcely known in the United States 10 years ago, and now reaches 200,000 tons, and they are driving cut nails out of the market.

As regards the uses of wire, I shall only shadow out a few of the principal and leading articles of the trade, such as fencing, telegraph, rope wire for hauling purposes, and for ships' rigging, and leave it to your own imaginations to fill up the thousand and one articles and uses to which it is daily applied for our wellbeing and comfort. It is used in our boots and shoes for rivets, and it is used in our hats for stiffening their brims; and in thus giving you the head and the feet, you can readily fill up the intervening space.

With reference to our production in this country, I find, according to the Board of Customs returns, that we exported in 1892 wire (excluding telegraph wire) 47,350 tons, as compared with 67,516 tons in 1891; and in estimating our total capacity, I should fancy that about 100,000 tons of wire rods of all grades can be rolled here annually; perhaps it may be capable of reaching as high as 120,000 tons.

THE EXHIBIT OF THE BETHLEHEM IRON COMPANY AT THE WORLD'S FAIR.*

By Lieutenant William H. Jacques.

If I can atone in any way for America's very inadequate representation of her steel productions by a recitation of what the Bethlehem Iron Company sent to the World's Columbian Exposition, I shall feel I have done a service to our profession. But I shall make no attempt to compare the Bethelehem exhibit with that of Mr. Krupp, which is a veritable exposition in itself, but shall present it only as showing the latest and highest development of the class of objects it covers.

On entering the Transportation Building, even those unacquainted with the products of iron works are attracted to the gigantic structure that strides the main aisle, like the Colossus of Rhodes. This is an exact reproduction of Bethlehem's 125-ton steam hammer—the largest in the world—under which the heaviest armor-plates are finished and shaped. It towers, 91 ft. in height, to the very roof beams, and so excellently have the wood and staff been molded together, that to all appearances the model is solid iron. The anvil-block could not be shown in place, as it would obstruct the passageway.

As a description of this hammer may be of interest, I present some details prepared for Mr. Swank for the last edition of his "Iron in All Ages." Although since the completion of the Parks Brothers' 17-ton hammer, two others of moderate proportions have been erected—viz., the 20 ton hammer of the Latrobe Steel Works and the Midvale hammer of 30 tons, both employing top steam to increase their forging power, it has been left for the Bethlehem Company to add to its already splendidly equipped plant the largest and most efficient hammer in the world—a single-acting instrument of 125 tons. The building in which this hammer has been erected is 500 ft. long, and is located on ground that was partly an island and partly the bed of the southern channel of the Lehigh River, turned from its course to provide the hammer site.

A pit 80 ft. square was excavated below the water level and piles were thickly driven, both for the anvil foundation and hammer frames. The stone walls for supporting the latter have a depth of 30 ft., separated from the anvil foundation lest any sinking of this latter should affect the framework of the structure itself.

The hammer rises to a height of 90 ft. from the floor-line. The housings proper are each composed of two parts, the lower ones weighing 71 tons each, the upper ones 48 tons each These are bolted together and surmounted by an entablature of 61 tons carrying a cylinder of 76 in. in diameter by 24 ft. high. The housings are clamped to base plates, each 10 ft. × 8 ft. and weighing 56 tons, giving a 42 ft. longitudinal width of frame and a working floor width inside of housing of 22 ft. A 16-in. steel piston-rod 40 ft. long actuates the enormous tup, which is composed of three parts, two forming the ram, a third the die. The hammer is single-acting, steam-lifting only, the total weight of falling parts, length of stroke and gravity governing the work done.

The anvil foundation consists of piles driven to bedrock or gravel, timber frames, cork and shavings cushion, steel slabs and 22 iron blocks carefully machined and fitted, forming a metal mass of 1,800 tons, arranged in the form of a pyramid. To secure an even floor for working, the spaces between the frame and anvil foundations are closed with cribbing, leaving exposed only the anvil block. The specially designed valve-gears have worked most satisfactorily, one man easily controlling the motions with one hand.

The hammer is served by four heating furnaces conveniently placed and by four gigantic cranes, each of 300 tons capacity, having longitudinal, transverse, vertical and turning motions, by which every position and movement of the forgings can be easily controlled.

In describing this hammer as one of 125 tons, it is meant that the weight of tup (including die), piston, and rod is 125 tons, which falling a distance of 16½ ft. (full stroke) without top steam produces the full power of the hammer.

The Principal Powerful Steam Hammers in the World are:

Company.	Town.	Country.	Type.	Weight in Tons.
Sir Wm G. Armstrong, Mitchell & Co., Ltd...	Elswick, N'-on-Tyne...	England.	Top-steam....	35
British Government....	Woolwich	England.	Top-steam....	35
Kama Steel Works.. ..	Perm............	Russia ..	Single-acting.	50
Aboukoff Steel Works..	Aboukoff........	Russia ..	Top-steam....	50
Cast Steel Works of Fried. Krupp.........	Essen...	Rhenish-Prussia..	Single-acting.	50
St. Chamond Steel W'ks	St. Chamond... .	France..	Single-acting.	80
Schneider & Co........	Le Creusot	France..	Single-acting.	100
Marrel Brothers........	Rive-de-Gier... .	France..	Single acting.	100
Terni Steel Works.... .	Terni	Italy.....	Single-acting.	109
The Bethlehem Iron Co.	S. Bethlehem, Pa.	U. S. ..	Single-acting.	125

In describing these hammers, the *weight* given is the sum of the moving parts—*i.e.*, piston, piston-rod, tup and die. The column headed *type* indicates whether top-steam is employed or not.

Begun in 1889, the Bethlehem hammer was successfully put in operation June 30, 1891, since which time many huge forg-

* Paper read before the Engineers' Club of Philadelphia.

ings for armor-plates and other war and structural material have been shaped under it.

The exhibit proper was divided into three sections. In the first were two immense steel forgings for the tube or barrel and jacket of a Navy 13-in. B. L. rifle, weighing respectively 26.3 tons and 25 4 tons—examples of hydraulic forged hollow steel forgings. Here was also the nickel-steel ventilator armor for the monitor *Puritan*, 7 ft. in diameter, 6 in. thick, weighing 9.1 tons, forged in one piece without welds. A feature of this section was a Navy 12-in. B.L. rifle, fabricated at the Washington Navy Yard of Bethlehem's fluid-compressed, hydraulic forged steel. It weighed 45.2 tons, was 37 ft. long, had a muzzle velocity of 2,000 foot-seconds, and fired an 850-lb. projectile with 425 lbs. of powder with an energy sufficient to perforate 22½ in. of iron. Its outside diameter was 3 ft. 9 in.

In the second section was a model of a 113-ton steel armor-plate ingot and a pile of forged steel hoops, with which were three splendid examples of steel armor. The largest was a curved 17-in. nick-steel plate, 12 ft. 1 in. long, and 8 ft. 4 in. wide, weighing 31.2 tons—one of 13 required to form a barbette of the battleship *Indiana*. The armor required for this battleship was:

Kind.	No. of Plates.	Thickness.	Weight, Tons.
Diagonal....	10	14	245
Side......................	20	18	650
Barbettes for 13" B. L. R.	26	17	810
" " 8" B. L. R..	8	8	115
" " 4" B. L. R..	4	6	48
		Total.........	1,863

The next was a case-hardened nickel steel plate, 10½ in. thick, 8 ft. long, 10 ft. wide, weighing 9.3 tons, which was subjected to an attack of the enormous energy of 25,040 foot-tons, during which the five 8-in., 250 lb. Holtzer armor-piercing shells lost their identity and were completely pulverized without seriously injuring the plate. The third plate was the first heavy steel armor-plate made in the United States. It was 11½ in. thick, 6 ft. long, 4 ft. 6 in. wide, and was tested in 1891. It weighed 5.7 tons. In this section was one of the most remarkable articles of the exhibit, a fluid-compressed steel ingot 15 ft. long, 54 in. in diameter, weighing 48.3 tons. From a similar ingot weighing 65 tons, the axle of the famous Ferris wheel was made. The third section contained a hollow hydraulic-forged shaft 67 ft. long and 20 in. in diameter, weighing 24.6 tons, with an internal diameter of 8½ in., forged in one piece; together with the paddle-shaft for the Old Colony Steamer *Puritan*, 39 ft. 5 in. long, 2 ft. 3 in. in diameter, having a 9-in. hole, and weighing 39.4 tons; and the crank-shaft for the United States cruiser *Minneapolis*, 9 ft. 7¾ in. long, 16¼ in. in diameter, having a 7½-in. hole and weighing 4 tons. Both of these were finished.

Accompanying these were a smooth forged trunnion hoop for a 12-in. armor gun, Whitehead torpedo, air flasks, air cushions, cylinders, sections of rails, specimens of nickel steel, etc.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.

SECOND SERIES.—CHEMICAL METHODS.

VII.—METHOD OF DETERMINING MANGANESE IN STEEL.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(*Continued from page* 129.)

OPERATION.

Put 3 grams of the fine borings in a 16-oz. Erlenmeyer flask, and add 50 c.c. of dilute nitric acid, specific gravity 1.13. Put on the steam table or over the lamp, and as soon as solution is complete, add 100 c.c. of concentrated C. P. nitric acid, specific gravity 1.42. Heat to boiling, withdraw from the fire momentarily, then add 5 grams of crushed chlorate of potash, free from manganese. Replace over the heat, and boil 10 minutes; then repeat the operation with 5 grams more of chlorate. Allow to cool, then filter through an asbestos filter, and wash both flask and filter with distilled water, until the washings no longer react acid. Put the asbestos with the manganese on it back into the flask, and add 50 or 100 c c. of ferrous sulphate solution; agitate until the manganese is all dissolved, then titrate the excess of ferrous sulphate with permanganate of potash.

APPARATUS AND REAGENTS.

The apparatus required by this method needs no especial comment, except, perhaps, the asbestos filter. The ordinary well-known funnel and platinum perforated cone may be used, but better the glass tube filter. Instead of using those made with constrictions, such as are usually shown in apparatus catalogues for filtering acid solutions, a tube drawn out at one end to go into the hole in the cork, and with a flat coil of platinum wire to hold the asbestos, is preferable. Those made from 1½-in. tubing, about 8 in. long when finished, and with the drawn-down portion about 3 in. long, work nicely. The flat platinum coil is about ¾ in. in diameter, and has a tail of the same wire hanging down from the center of the coil, about 4 in. long, to assist in removing the filter from the tube after the washing is finished.

The C. P. nitric acid is obtained in the market, and the dilute is made from it by adding distilled water.

The chlorate of potash is the commercial salt obtained in the market.

The asbestos which works best is the mineral known as actinolite. Much of the asbestos of the market packs badly under suction and retards filtration.

The ferrous sulphate solution is made by adding 2 liters of concentrated C. P. sulphuric acid, specific gravity 1.84, to 14 liters of distilled water in which has been dissolved 80 grams of C. P. ferrous sulphate. It is not necessary to filter. After all the reagents are together the solution is thoroughly mixed, and its strength obtained in terms of the permanganate solution. Fifty c.c. of the ferrous sulphate solution require about 15 c.c. of permanganate. Not less than three tests should be made, and they should agree within a tenth of a c.c. If not the temperatures, the burette, the pipette, or the mixing of the solutions, one or all, are at fault.

The permanganate of potash solution for titration is made as follows: To 1 liter of water add 2 grams of crystallized permanganate of potash, and allow to stand in the dark not less than a week before using. Determine the value of this solution in terms of metallic iron. For this purpose 150 to 200 mg. of iron wire or mild steel are dissolved in dilute sulphuric acid (10 c.c. of strong C. P. acid to 40 c.c. of water) in a long-necked flask. After solution is complete, boil 5 to 10 minutes, then dilute to 150 c.c., pass the liquid through the reductor, and wash, making the volume up to 200 c.c. Now titrate with the permanganate solution. It is, of course, essential that the amount of iron in the wire or soft steel should be known. The standard in use in the Pennsylvania Railroad Laboratory is a mild steel, in which the iron is known by determining carbon, phosphorus, silicon, sulphur, manganese and copper, and deducting the sum of these from 100 per cent. Not less than two determinations are made, and three are better. The figures showing the value of the permanganate solution in terms of metallic iron should agree to a hundredth of a milligram in the different determinations. A very satisfactory method of making and keeping permanganate of potash solution is as follows: Have a large glass bottle holding, say, 8 liters and two of half the size. Paint the outside of these bottles with several coats of black paint or varnish. Fill the large bottle with the standard solution, and after it has stood a proper time, fill one of the smaller bottles from it without shaking and standardize. At the same time fill the second small bottle and refill the large one. When the first small bottle is exhausted, standardize the second one and fill the first from the stock. When this is exhausted standardize the first again and fill the second from stock, refilling again the stock bottle and so on. By this means a constant supply of sufficiently matured permanganate is always available. Of course if the consumption is very large, larger bottles or more of them may be required. Since changes of temperature affect the volume of all solutions, it is desirable that the permanganate solution should be used at the same temperature at which it was standardized. With the strength of solutions above recommended, if the permanganate is used at a temperature of 20° F. different from that at which it was standardized, the error amounts to less than 0.003 per cent. on a steel containing 0.50 per cent. of manganese.

CALCULATIONS.

Atomic weights used: Iron, 56; manganese, 55. Molecular formulæ used: Ferrous sulphate, $FeSO_4$; manganese dioxide, MnO_2; sulphuric acid, H_2SO_4; permanganate of potash, $K_2Mn_2O_7$; water, H_2O. Reaction in ferrous sulphate solution, $MnO_2 + 2\,FeSO_4 + 2\,H_2SO_4 = MnSO_4 + Fe_2\,(SO_4)_3 + 2\,H_2O$.

The soft steel employed in standardizing permanganate of potash solution in the Pennsylvania Railroad Laboratory contains 99.27 per cent. metallic iron; 0.1498 gram of this con-

tains therefore (0.1498 × 0.9927) .1487064 gram of metallic iron. This requires, say, 42.9 c.c. permanganate solution, or 1 c.c. of permanganate solution is equal to (.1487064 ÷ 42.9) .003466 metallic iron. Assuming now that the manganese oxide obtained is MnO_2, it is obvious that two molecules of $FeSO_4$ are required for reaction with one molecule of MnO_2, or the ratio between Fe and Mn in the reaction in the ferrous sulphate solution is as 112 to 55. But each c.c. of permanganate is equal to .003466 of metallic iron, and consequently (112 : 55 :: .003466 : .0018) each c.c. of permanganate is equal to .0018 gram of metallic manganese. Suppose now that 50 c.c. of the ferrous sulphate solution is equal to 14.9 c.c. of the permanganate solution, and that after the manganese oxide on the asbestos filter has been added to 50 c.c. of the ferrous sulphate solution, and the reaction between these is complete, it requires 4.1 c.c. of the permanganate solution to react with the excess of ferrous sulphate. It is evident that the amount of manganese in 3 grams of steel is equivalent to (14.9 — 4.1) 10.8 c.c. of the standard permanganate solution, that is to (10.8 × .0018) = .01944 gram of metallic manganese. Then if 3 grams or parts of steel contain .01944 gram of manganese, 1 gram or part would contain (.01944 ÷ 3) .00648 gram, and 100 grams or parts would contain (.00648 × 100) .648 gram or 0.648 per cent. This explanation may be briefly summarized as follows: Obtain the strength of the permanganate solution in terms of metallic iron. Then obtain the strength of the same solution in terms of metallic manganese in accordance with the reaction given above. Next find the equivalent of the amount of ferrous sulphate solution to be used in an analysis in terms of the permanganate solution. Then, after the number of c.c. of permanganate solution, equivalent to the manganese in the steel are obtained, multiply these by the manganese equivalent of the permanganate solution. Move the decimal point two places to the right, and divide by 3. The quotient will be the per cent. of manganese in the steel. It is, of course, evident that the manganese equivalent of the permanganate may be divided by 3, and the decimal point moved two places to the right before multiplication, which still further simplifies the calculation.

NOTES AND PRECAUTIONS.

This method, it will be observed, separates the manganese from the iron in nitric acid solution by means of chlorate of potash, catches the precipitated oxide of manganese on an asbestos filter, and determines the amount of the manganese by means of the reaction between ferrous sulphate and this oxide in sulphuric acid solution permanganate of potash being used, to measure the change in the ferrous sulphate solution, produced by the manganese oxide.

The use of dilute nitric acid to effect rapid solution of the steel, and the subsequent addition of the specified amount of concentrated acid, is found to give exactly the same results as are obtained when the steel is dissolved in concentrated acid from the start, or as are given when a larger quantity of dilute acid is used to start with, followed by subsequent concentration. The saving in time by the method recommended amounts to from one to two hours.

It sometimes happens that no precipitation of manganese oxide will follow the first addition of chlorate, and even sometimes the second addition is very slow in producing a precipitate. It is hardly safe to pronounce no manganese present until quite continued boiling, and further additions of chlorate, and even more nitric acid and further boiling leave the solution quite clear. After the precipitation is once started it apparently goes on to completion without difficulty. It is not advisable to add the chlorate of potash to the boiling solution over the fire. Under certain conditions disastrous explosions follow such practice.

It occasionally happens that permanganic acid is formed in the nitric acid solution. When this is the case, the filtrate will in some cases at least be clearly pink in color, and on standing oxide of manganese will separate. It is believed that this possible difficulty is obviated by allowing the nitric acid solution to cool before filtration. This practice is regarded as better than adding fresh unboiled concentrated nitric acid, as has been recommended, since fresh nitric acid may contain nitrous acid, in the presence of which the separated manganese is somewhat soluble.

The length of time that the nitric acid solution with the separated manganese oxide in it may stand without injury seems to be considerable. Duplicate determinations made on the same steel, in one case as rapidly as the manipulation could be carried through comfortably, and in the other case, allowing the precipitated oxide to stand in the nitric acid solution 12 hours before filtration, gave exactly the same results in both cases. Diluting the acid with water after the flask is removed from the fire and then allowing to stand is disastrous. A direct test showed that in 12 hours' standing under these conditions about half the manganese had dissolved. Of course during standing the flasks should not be exposed to direct sunlight for fear of formation of nitrous acid.

It does not seem to be necessary to wash the precipitate on the filter with either concentrated or dilute nitric acid, as was formerly directed. As soon as the liquid from the flask has all run through, water may be used at once for washing both flask, filter tube, and filter.

The necessity for the complete removal of every trace of nitric acid by the washing is very great. A very small amount of nitrous or nitric acid in the ferrous sulphate solution may so interfere with the permanganate titration that the results will be worthless. Large quantities of water may be safely used in the washing, and the last drops from the filter tube should be tested with phenolphthalin, or some other delicate indicator.

Whether it is advisable to use the pump or not during the filtration seems to be largely a question of the asbestos used. With certain kinds of asbestos a plug ¼ in. or more in thickness may be used in the filter tube, and the suction from the pump applied vigorously. With other kinds of asbestos this procedure results in packing the asbestos so tightly that filtration is retarded, and the subsequent solution of the manganese oxide in the ferrous sulphate solution is also seriously retarded. A mixture of poor asbestos with glass wool works nicely with the pump. Where one operator has six or eight determinations to filter at one time there is no advantage in the pump. With a properly made asbestos filter the liquid will run through as rapidly as it can be poured into the tubes.

The asbestos for filters can be used over and over again, and does not seem to deteriorate from use. After the titration is finished the flasks are emptied into a large beaker, the liquid drained off, and the asbestos washed three or four times by decantation, when it is ready for further use.

For steels containing 0.90 per cent. or over of manganese, it will be necessary to use more than 50 c.c. of the ferrous sulphate solution. In case the manganese oxide does not completely disappear after a little agitation when 50 c.c. of the ferrous sulphate solution has been added, leaving the asbestos perfectly white, add 50 c.c. more of the same solution and agitate again. Of course the calculations must be varied in accordance with this change.

Very few steels contain enough silicon to cause trouble in the filtration provided the pump is not used, and it is very rarely necessary to separate silicon before determining the manganese. When the amount of manganese is very large, the filtration is sometimes slow, but if care is taken to keep the tube full of liquid and not to pack the asbestos too tight, there is usually no serious difficulty.

There are some indications that the separated oxide of manganese may not be exactly MnO_2. Positive experiments on this point are wanting, but comparative experiments on the same steel by the method given above, and by the acetate-bromine method, show that for steels containing not more than 1 to possibly 1½ per cent. of manganese, the error, if any, can safely be ignored.

When everything works well a determination can be made by the method above described in from an hour to an hour and a half.

MEETING OF THE MEMBERS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

RECENT IMPROVEMENTS IN THE EMERY TESTING MACHINE.

THE March meeting of the members of the American Society of Mechanical Engineers was held at the house of the Society in New York, on the evening of Wednesday the 14th, with Mr. Eckley B. Coxe in the chair. The paper of the evening was read by Mr. Sellers Bancroft, and related to the recent improvements that have been made in the Emery testing machines. Mr. Bancroft spoke as follows:

Mr. Chairman and Gentlemen:

I propose to describe to-night some of the recent improvements in the Emery testing machine, but in order that those improvements may be thoroughly understood, it is perhaps necessary to go over ground which is familiar to many of you, and for that purpose I have a view showing just the scheme of the machine.

The essential peculiarity of the Emery testing machine is the method by which the stress produced upon the piece tested is conveyed to the scale and accurately weighed by mechanism that is entirely frictionless, and that hence responds to the same

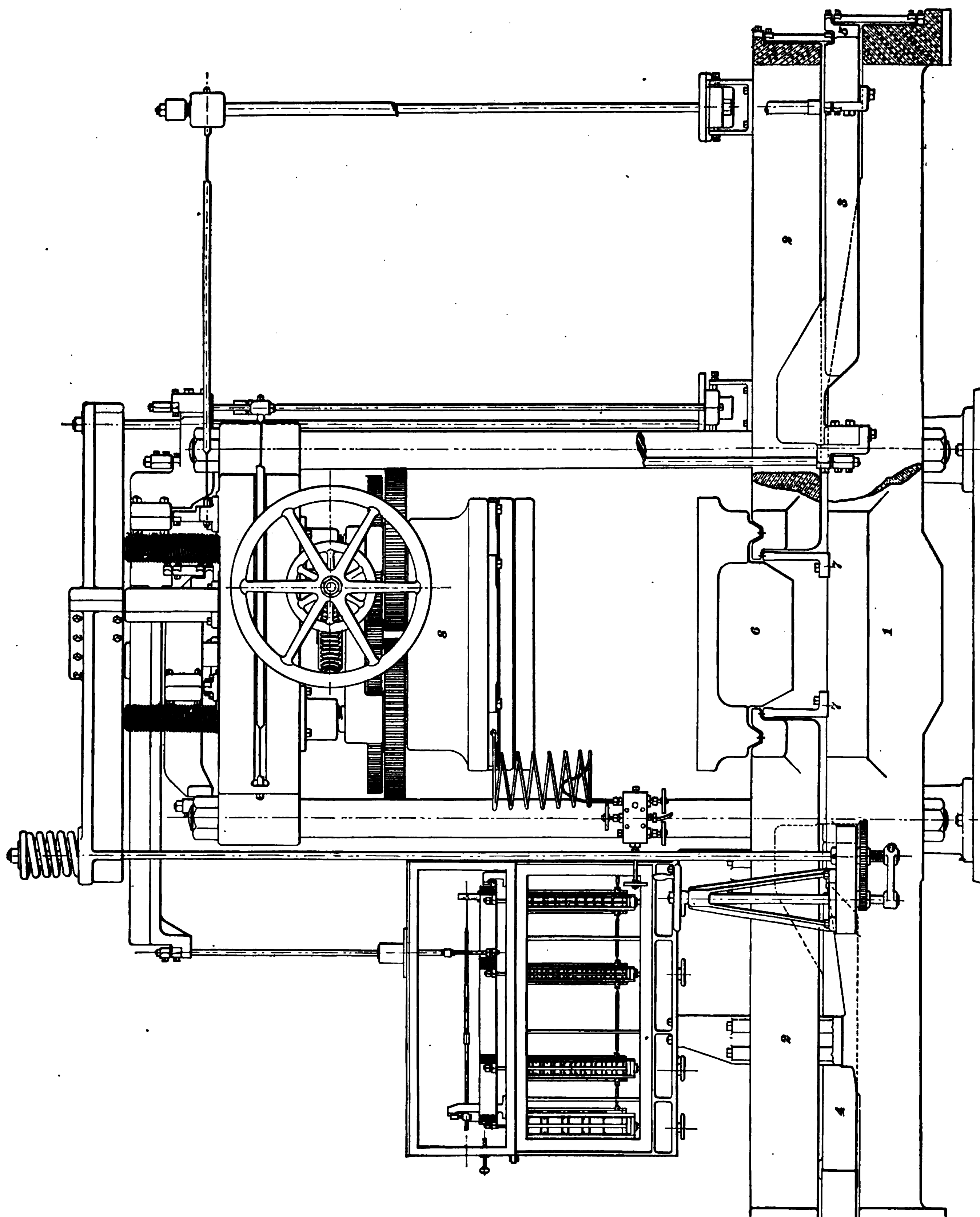


Fig. 4.
SUPPORT TESTING MACHINE.

increment of load regardless of the amount of strain upon the specimen.

This result is accomplished by receiving the load upon a hydraulic support or upon a group of them, as the case may be. The general scheme is indicated in fig. 1, which merely shows the relation of the parts, no attention being paid to proportion. The depth of the cylinder *a*, which merely represents the main hydraulic support, is exceedingly shallow, and the end is closed to prevent the escape of the contained fluid by a thin sheet of metal *b*, upon which rests a piston *c*, considerably smaller than the internal diameter of the cylinder, giving a free span of metal between the two. This piston is secured to the cylinder by a thin flexible fixing plate or plates *d*, *d*, which permit a very small movement in the direction of the axis of the cylinder, while rigidly securing it against any lateral movement. This longitudinal movement of the piston from no load to full load is not more than, say, .003 in., and as there is no hydraulic packing and no sliding, there is no friction beyond that of the fluid. This hydraulic chamber is filled with liquid and connected by a pipe, *e*, with a smaller but similar chamber *B*, the ratio between the two being from 20 to 1 to 30 to 1 on small scales to several hundred to one on large scales. This small chamber is placed in the scale, which may be at any reasonable distance; the piston *c'* of this latter chamber acts through the block *H* against the first lever *C* of the scale, which thus receives a fraction of the load upon the piston *e*, determined by the relation between the areas of the two hydraulic cylinders *A* and *B*.

The scale body is a rigid cast-iron frame indicated by the shade lines under the lever supports *G*, *G'*, *G''*, and over the reducing chamber *B*. All the supports and connections of these levers are thin flexible plates of steel firmly secured or clamped to the levers and their supports, and having a sufficient exposure between their fixed ends so proportioned to their thickness and the loads they have to carry that the amount of bending due to the movement of the levers shall be well within the elastic limit of the material. The long arm of the lever *C* is coupled by the bar *D* with the short arm of the poise frame lever *E*; the long arm of this lever carries all the standard weights of the scale, and the method of putting them on or taking them off is peculiar to the Emery system. Suspended from this lever *E* at suitable intervals by thin fulcrum plates are poise frames *N*, consisting of an upper cross-head *S* and a lower cross-head *T*, united by three vertical bars disposed at equal intervals about the cross-heads.

These bars are provided on their inner faces with short projecting brackets *V* having a horizontal surface and a beveled surface, which correspond with similar surfaces formed on the weights *h*, which are short cylinders or rings with beveled edges; the weights are carried by the flat surfaces and centered by the beveled surfaces. A weight frame *M* of the same construction has its three vertical bracketed bars alternating with the bars of the poise frame; this weight frame is guided and is raised and lowered in a vertical line without touching the poise frame by a rock-shaft and hand lever coupled to the rod projecting from the cross-head *R*. The brackets on the weight frame bars are differently spaced from those on the poise frame, and when the weight frame is at the top of its stroke it carries all of the weights clear of the poise frame; a small movement downward transfers one weight to the poise frame, the beveled surfaces on the brackets centering the weight if it is displaced sideways by a too sudden movement. A further movement transfers another, and so on—that is, the movement of the weight frame in either direction transfers the weights singly and successively from one frame to the other. The weights *f* and *g* are shown carried by the poise frame, *j* and *k* by the weight frame, while *h* is being transferred from one to the other.

The operating hand lever is provided with a notched segment into which a click spring plays, so that the operator feels when he has moved the lever the right distance to transfer a weight without having to watch the indicator, as formerly, and the arrangement of the six bars surrounds the weights by a cage that effectually prevents any displacement and consequent interruption of the test, as sometimes occurred when the weights rested on simple shelves secured only by short pointed pins. There is hence no necessity for opening the glass case that encloses this part of the scale, and the weights are never exposed to any risk of alteration. The weights in the first poise frame have a value of 100 lbs., the next frame carries weights of a value of 10 times as much, or 1,000 lbs., the next 10,000 lbs., and so on, and the readings are summed up by a series of segments connected to the several operating shafts and provided with figures denoting the number of weights on each poise frame. A horizontal slot in a vertical plate near the upper left-hand corner of the scale is so placed that the reading of the figures shown through this slot denotes the number of pounds pressure applied to the specimen.

There is no calculation required. Those weights show right alongside of the index, and at the same time the centrality of the figures in that slot show at once whether the operator has moved the operating lever of the weight frame to the right point. Now, there is no rubbing on any part of the scale. The movement of the flexible plates and of the fulcrum plates of course requires power. It takes force to move them. But as the plates are made so that with the greatest stresses that come on them they are away within the elastic limit, they will give that force back on returning to the position of equilibrium, and no matter which way the needle is disturbed from the zero point, it will return to it again. The only friction about the machine that may be considered friction at all is that of the transfer of friction from this large chamber, which receives the weight, to the small or reducing chamber in the scale case, and in the smallest scales the motion of the point of the needle, which is about 2 in., is in the neighborhood of 360,000 times the motion of this piston, and on the large machines may be as much as 6,000,000 as much. That is based on the ratio of the levers and the ratio of the areas of the two cylinders. Of course there is another factor which comes in to increase the motion of this small piston, and that is the spring of the parts between this support of the scale in that scale frame and the upper support there. That material, of course, stretches, and the stretch due to the elasticity of that material and the compression of the parts *G*, *H*, and *C* and *C* 1 *C'* is more, actually, than the motion due to the mechanical ratio of the parts.

The Emery testing machines are now made horizontal instead of vertical; in the first place, to make all sizes of machines of one type; and, in the second place, to get certain advantages in overcoming the shocks of recoil. In all but the very smallest size of machines, the weighing head and the hydraulic cylinder or straining head are carried and aligned by the top surface of a wrought-iron bed, as shown in this view of a 200,000-lb. testing machine, the straining head on the right hand and the weighing head on the left, back of which stands the scale, and to its right is the pump; in the foreground are the parts of the tension holders.

The weighing head, fig. 5, consists of two circular or annular beams 65 and 69, firmly secured together by bolts placed around their periphery and by the straining screws which pass through both beams and clamp them by a shoulder and nut. This head and the straining head fit easily upon the bed, which maintains the axes of the two heads in the same straight line. A drawbar, 70, is secured in the axis of these beams by two thin annular steel plates, 72, bolted against shoulders near the ends of the drawbar and secured firmly in recesses formed in the outside face of each beam. These plates hold the drawbar securely in line with the axis of the machine, while permitting a free motion to a limited extent in the direction of the axis. The projecting end of the drawbar is provided with a screw thread by which the compression platform or the tension holder is secured to it. The drawbar is enlarged in the middle, and against each of the two shoulders thus formed is secured a thin annular steel plate, 73; these plates are for the purpose of carrying and centering the hydraulic support, which is made annular instead of circular, as shown in fig. 1, and is placed centrally about the axis of the drawbar, so that end stress on the drawbar is resisted symmetrically by the hydraulic support, the part corresponding to the cylinder being secured to one plate and an abutment ring secured to the piston being secured to the other plate, while the cylinder and piston are also separately coupled by flexible plates. By this means the hydraulic support is maintained in fixed relation with the drawbar laterally, while it is left free to move relatively to it in the direction of its axis through the small distance required. On each side of the hydraulic support steel collars, 71, are screwed and secured to the drawbar; these collars are provided on the periphery with a series of ribs (see fig. 7), parallel with the axis of the drawbar, and which lie between without touching, similar ribs projecting from the interior surface of the annular beams. The ends of all these ribs on the two beams and the collars are accurately faced to true planes at right angles to the axis of the drawbar, and the distance between the two extreme faces of the hydraulic support is made slightly less than the distance between these two planes. Movement of the drawbar in either direction carries the hydraulic support against the ends of the ribs in one annular beam, and brings the ends of the ribs on one of the collars on the bar against the opposite side of the hydraulic support, and produces pressure on the contained liquid which is transmitted through the pipe 63 to the small hydraulic chamber in the scale. For the purpose of ensuring that everything about the hydraulic chamber has a solid bearing, it is necessary to produce an initial loading of about 5 per cent. of the

maximum load, which is done by applying a definite spring pressure to move the drawbar in the direction in which the stress to be applied to the specimen will move it, and after this the scale is balanced in the usual way by sliding weights on the poise beam. In order to prevent the shock of recoil, resulting from the rupture of a large specimen of high steel, from doing injury to the thin brass plates in the hydraulic support, the abutting pieces 64, of the support which rests against the ribs in the annular beam 65, when strains of tension are applied, is made larger in diameter than the hydraulic support proper, and is provided with a spiral or screw face 66, which engages with a corresponding screw face formed on a rotatable ring, 67, fitting in the other annular beam 69. After the initial load has been applied, this ring is rotated by the pinion shaft 68, to bring the screw faces in contact (see fig. 6), and the abutting piece 64 is thus clamped firmly to the annular beam against which it rests. When the specimen breaks, its first blow is delivered through the drawbar and ribbed collar to this abutting piece 64, which transmits it through the ring 67 to the rear annular beam 69, and as these beams 65 and 69 are rigidly united, the blow is absorbed by the total mass of these two beams. The hydraulic support is thus thoroughly protected, and these machines can be used regularly for breaking high steel specimens up to the full capacity of the machine without any risk of injury.

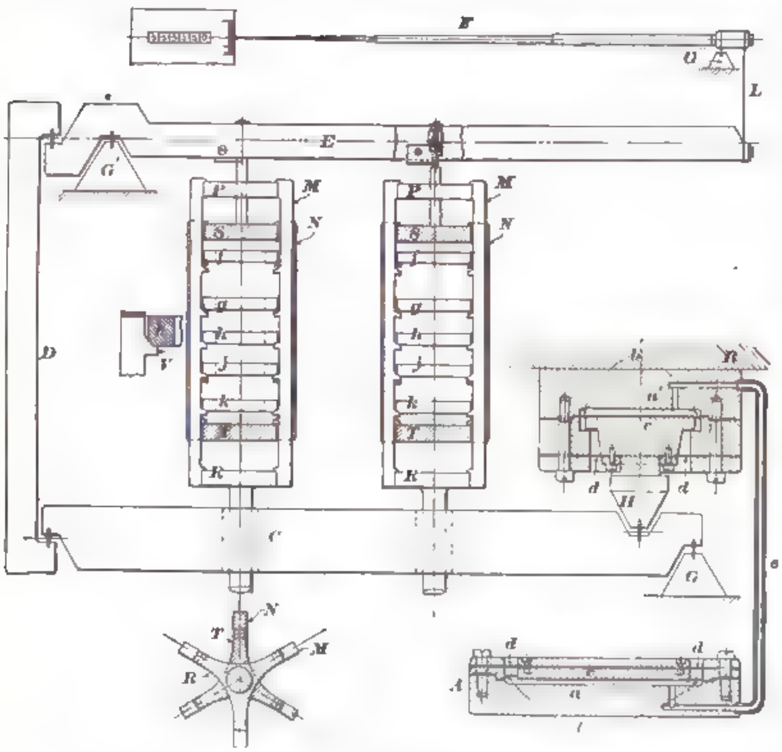


Fig. 1.

GENERAL SCHEME OF EMERY TESTING MACHINE.

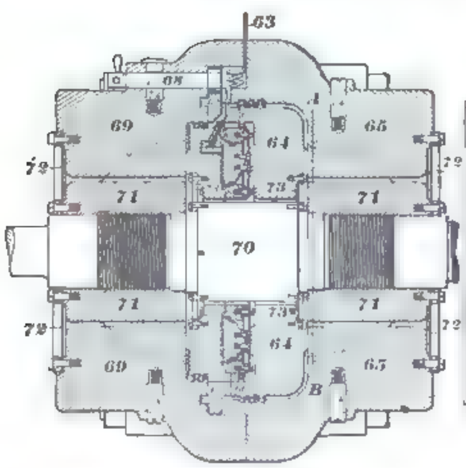
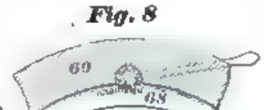


Fig. 5

Fig. 6

Fig. 8



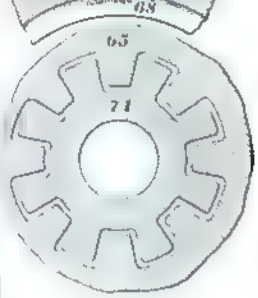


Fig. 7

The weighing head is returned to its place on the bed after movement due to recoil by a set of spiral springs locked up in boxes secured to the bed, shown at the extreme left-hand end of fig. 2; these springs are strong enough to move the head, and their resistance diminishes greatly the movement due to recoil, while the friction of the head upon the bed rapidly wipes out the oscillations.

The annular beams bolted together, as described, constitute one built-up beam to resist the bending due to the pressure on the drawbar midway between the straining screws. The hydraulic support is thus enclosed in a rigid mass of cast iron and effectually protected against injury from violence or from being gummed up by oil from the straining cylinder, as has occurred with the upright machines, and the frictionless movement of this support under all conditions of service is thus secured.

The fixing plates of this construction are short and direct, and there is no opportunity after that is once assembled for any tampering with it or any getting inside of it to in any way hamper its movement.

Figs. 9 and 10 show a method of making the hydraulic support for very large machines, or when the annular support just described would become too large to be rated by the support testing machine. In this case the supports are made circular and are grouped symmetrically about the axis of the drawbar; as shown in fig. 9, they may be all coupled together by one pipe or connected, as shown, by individual pipes to one or more reducing chambers in the scale. The cylinders of the supports are secured to the ring 75 and the pistons to the ring 76, which is provided with a screw thread on its overhanging rim, and is clamped by the ring 67, as before described.

Two straining screws 77 are provided (see figs. 15, 16, and 17), fixed firmly to the weighing head and passing freely through bearings 88, formed on each end of the straining head 87; a revolving nut, 89, provided with gear teeth on its periphery is placed on each straining screw between the two bearings 88 formed on the sides of the straining head; these nuts are revolved by the wide face pinions 90, driven through the bevel wheels 92 and 93 by a balancing train of gearing consisting of a gear wheel 96 carrying two balancing bevel pinions (see fig. 17), meshing with two bevel wheels, one on each side of the first gear wheel 96, so that power applied to the gear 96 is by means of the balancing pinions divided equally between the two bevel wheels, and thus imparts equal pressure to the revolving nuts 89 on the straining screws. This arrangement does away with the necessity heretofore existing of having the straining screws of exactly similar pitch throughout their length. With this construction the screws could be of different pitches, the alignment of the heads being secured by the fit of the screws in their bearings and of the heads on the wrought-iron bed or shear; by driving this train of gearing either by hand or by power the straining head is moved back and forth upon the bed to accommodate the varying lengths of specimens; when the head is adjusted to place, the nuts form the abutments upon the screws to resist the movement of the cylinder for strains of compression or extension. The nuts 89 do not fit snugly endwise, as heretofore, but a space of several inches is left between the ends of the nuts 89 and the faces of the bearings 88 (see fig. 15). This provides for the shock of recoil when breaking a long and large specimen, the sudden release of the straining screws from their load when the specimen breaks, together with the force resulting from the sudden contraction of that end of the specimen attached to the straining head, merely give the head a push along the bed and it slides freely until its momentum is absorbed by its own friction, the space between the revolving nuts and the bearings allowing ample room for this travel under the best conditions

of lubrication. This head is thus entirely cut off from the rapid vibrations of the straining screws, and the necessity of making the nuts an exceedingly good fit to both screw and head is entirely avoided.

The straining head is provided with a piston packed to receive fluid pressure in either direction, and the piston-rod passing through a packed bearing in one end is provided with a screw thread, similar to that on the drawbar, to receive the various holders. The fluid is supplied to this straining cylin-

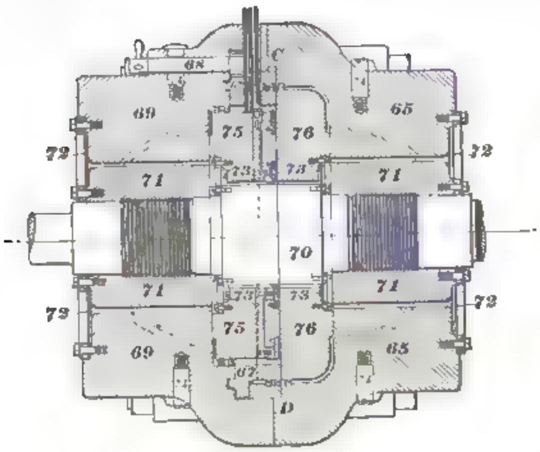


Fig. 10

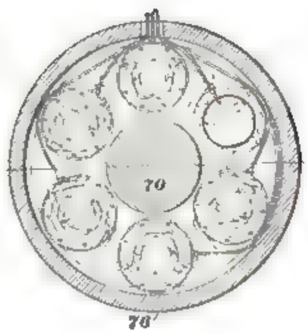


Fig. 9

der through two systems of jointed pipes, which are connected through the valves at the scale case with the presure pump and the tank respectively, so that each pipe acts either as a pressure-pipe or an exhaust-pipe, depending upon the direction in which the strain is to be exerted upon the specimen.

The tension holder for gripping specimens for extension tests is shown in section in fig. 21 ; a steel case consisting of the two parts 99 and 107, united by the nut 108, is secured to the end of the drawbar or piston-rod by the screw thread described. The gripping jaws 110 are two cylinders that slide freely in cylindrical holes bored in the case 99 at an angle of about 20° with the axis of the case, making an angle of, say, 40° with each other, the axes of the jaws and of the case being in the same plane. The rear end of each of these jaws is provided with a "T" slot lying in this plane and at right angles to the axis of the case, which engages with a "T" rib formed on a cross-head 106 that fits in a bearing in the case, and compels the jaws to move equally and simultaneously (see fig. 25). The cross-head is provided with a screw thread in its interior to receive an abutment screw 103, which forces the jaws forward and closes them upon the specimen. This screw is operated by an annular worm gear 102, provided in its interior with two narrow lugs (see figs. 22 and 23), which engage with two similar lugs formed on the abutment screw, so that the worm-wheel could make almost a half revolution without moving the screw to which it is coupled by a strong spiral spring, fig. 24. Cylindrical recesses are formed in the opposing faces of the jaws to receive the hardened steel gripping dies 111 and 112, which are made of various sizes and shapes to receive flat, square, or round specimens. The forward half of these dies 112 is made parallel and smooth and of a shape to conform to the section of the specimen ; following this the die 111 has a series of alternate V-shaped ridges and grooves running transversely to the length of the specimen ; the apex of the ridge next to the parallel die 112 being truncated, so that it stands a very little above the surface of the parallel die ; the next ridge is truncated less and stands higher, and so on until the last ridge, which is left sharp (see fig. 26). The dies are closed upon the specimen to be tested, by turning the worm-wheel which, by means of the abutment screw 103 and cross-head 106, pushes the jaws forward until the sharp ridge on the dies rests against the specimen ; further revolution of the worm gear then winds up the spiral spring until the driving lugs on wheel and screw come in contact, when the sharp ridge is forced into the specimen sufficiently to insure that the friction between the dies and the specimen shall be greater than that between the jaws and the case. When stress is applied to the specimen the jaws will be drawn forward, sinking these ridges successively into the specimen until the parallel part of the dies grip it firmly, the idea being that the parallel part will hold with more than sufficient friction to compensate for the depression made in the specimen in the first ridge, and so on to the last, so that a bar of metal can be put into this holder without any preparation and broken without any risk of being broken in the gripped part. As the jaws are drawn forward the spiral spring unwinds and keeps the abutment screw tightly pressed against the cross-head, holding it against the ends of the jaws, and taking up all lost motion, so that accurate centering and gripping of the specimen, no tearing strains, accuracy of weighing at all times, definite weights applied at each movement, and great rapidity for commercial testing is obtained, while when the specimen breaks it will in all cases be firmly held in the dies, and there will be no disturbance nor flying pieces, nor any noise beyond that of the broken piece itself.

The form of pump that we are now using is a three-throw crank type coupled by connections to links vibrating about this center. These links then have the constant stroke due to the crank, which runs about 100 revolutions a minute. At the back there are the cylinders, with valve and check-valve and cross-head there, and the connection here which couples to the link-block sliding in this link. Those links can be raised right up to the center of the shaft, so that the stroke of the pump plunger is stopped entirely, and they can be lowered until the pump has a stroke of 5¼ in., so that by raising and lowering that you get any stroke between the two extremes, or any rate of flow that may be desired.

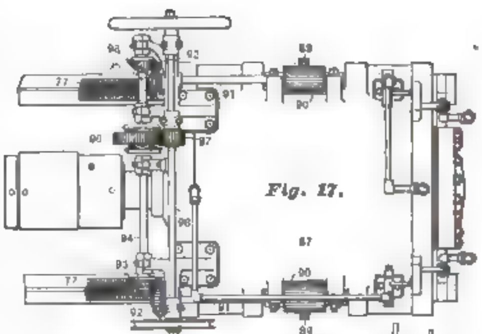


Fig. 17.

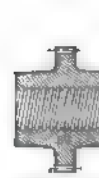


Fig. 18.

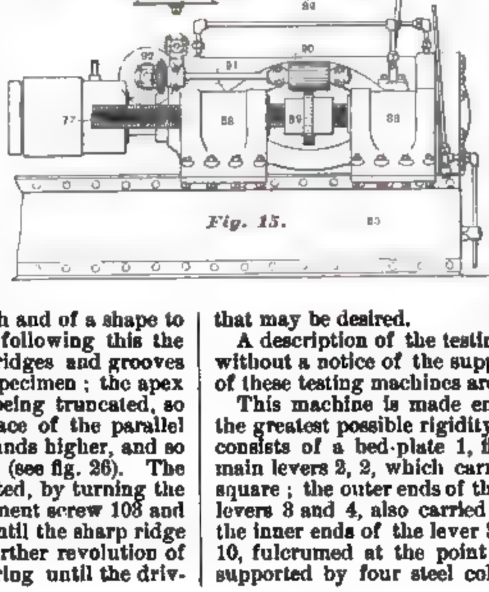


Fig. 15.

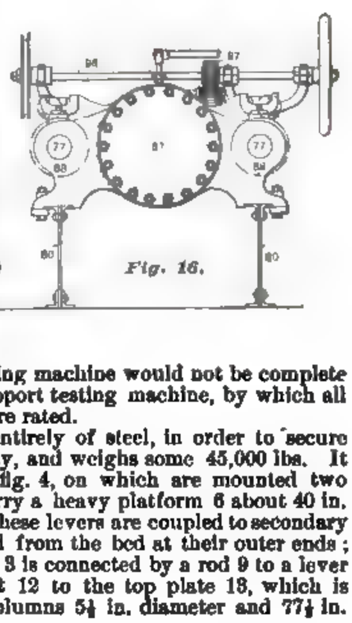


Fig. 16.

A description of the testing machine would not be complete without a notice of the support testing machine, by which all of these testing machines are rated.

This machine is made entirely of steel, in order to secure the greatest possible rigidity, and weighs some 45,000 lbs. It consists of a bed-plate 1, fig. 4, on which are mounted two main levers 2, 2, which carry a heavy platform 6 about 40 in. square ; the outer ends of these levers are coupled to secondary levers 3 and 4, also carried from the bed at their outer ends ; the inner ends of the lever 3 is connected by a rod 9 to a lever 10, fulcrumed at the point 12 to the top plate 13, which is supported by four steel columns 5¼ in. diameter and 77½ in.

long from bed to top plate, 3¼ in. diameter in plate. The lever 10 on top is connected by a rod 15 with the poise frame lever 16 in the scale, from which lever all the poise frames are suspended and to which the indicator needle is connected; the second lever 4 is connected by a rod 9 to one end of the equal-armed lever 11, 11, fulcrumed at the point 14 to the top plate 13, and at the point 17 to the lever 10, the lever 11 serving to transfer the downward pull on the rod 9' to the lever 10, so as to have the same effect as the pull on the rod 9. All of the supports and connections of all the levers are the Emery flexible fulcrum plates varying in thickness from about .005 in. at the needle to $\frac{3}{16}$ in. at the platform, which is designed to carry 500,000 lbs., and has carried 600,000 lbs. without any signs of injury, the ratio from the platform to the point of the needle being 806,600 to 1. Close to the fulcrum of the second lever 3, an auxiliary weighing platform 18, having a capacity of 5,000 lbs., is arranged, and hung from the lever 10 on the top plate is another platform 19, of 500 lbs. capacity. This large scale shows conclusively that the use of fulcrum plates instead of knife edges eliminates friction; a weight of 200 grains laid on the main platform puts in motion material weighing more than 25,000 lbs., and moves the needle .02 in., and in all of our experimental work on this machine we were unable to perceive any reduction in this sensitiveness when fully loaded. The same weights are used for the three platforms, being decreased in value for the small platforms by the ratio that they bear to the main platform, thus a 1,000 lbs. weight in the scale balances 1 lb. on the 500-lb. platform, which turns with half a grain.

Pressure is applied to the platform of this scale by means of an upper platen 8, movable by four large loading screws, carried by nuts bolted to the top plate, by means of a large hand-wheel and worm gear. These screws are operated with the greatest nicety, so that the pressure upon any object resting on the scale platform can be adjusted exactly. The main hydraulic support of every testing machine built by us is placed on this platform and connected with the reducing chamber in the scale which is to be used with the machine. Definite loads are then applied by means of the loading screws, and the weights in the poise frames of the testing machine scale carefully adjusted to correspond; in this way every machine is rated accurately by small increments of load up to its full capacity, nothing being taken for granted. For very large machines, where the size of the annular hydraulic supports would be beyond the capacity of this machine, the supports are made circular and grouped around the drawbar as before described, and by testing these supports first separately and then collectively, a testing machine of, for example, 10,000 tons capacity, could be accurately rated throughout its full range, giving an absolute certainty as to results never before attained.

The original rating of this machine presented some very curious problems which gave a great deal of trouble to solve, but ended in convincing us that while the machine is exceedingly sensitive to change of load, it is also, which is a rare combination, equally insensitive to rough usage, such as severe side strains and twists.

Fig. 23

Fig. 24

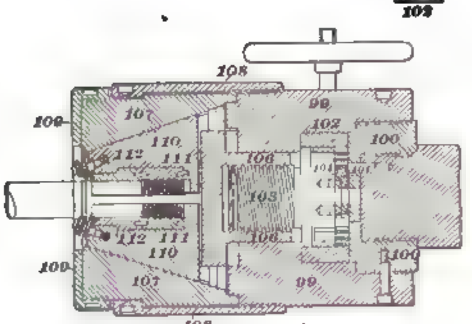


Fig. 21

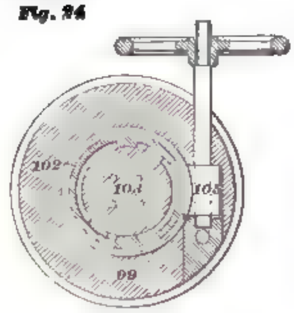


Fig. 22

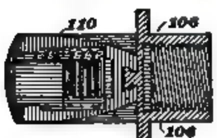


Fig. 25

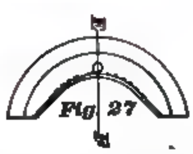


Fig. 27

Fig. 26

The method of rating proposed was to place a standard weight on the platform and balance it by small standard weights placed in one of the poise frames; then to remove this standard and apply pressure to the platform by means of the loading screws until the small weights were again balanced; then to replace the standard and see if it was again balanced by the same amount of small weights, the weighing of the machine being assumed to be correct if this standard weight would be balanced by the same small weights under all conditions of loading, and so on until the full capacity of the machine was reached.

The standard first used weighed 1 ton, and as the loads were applied by the screws, its balancing weight fell off until it required only four-fifths of the small weights to balance it; that it took when on the empty machine; in other words, it weighed but 1,600 lbs., and from that point on up to the full capacity of the scale it weighed 1,600 lbs., neither more nor less. The first inference was that some part of the scale was not solidly fitted, and that under this load it settled to place. An initial load of 30,000 lbs. was applied by steel bars placed so as to act as load springs, but without producing any change in the action of the machine. The machine was then taken apart, but a very careful examination failed to detect any defect. Supposing that the defect might be too small to be readily discovered, an effort was made to exaggerate it and so locate it by packing the lever supports out of level and in wind. The machine required rebalancing, of course, but nothing that we did disturbed the action of the weight, nor the sensitiveness of the scale, nor the regularity of weighing when the critical point was once passed. The screws and gearing actuating the platen were then thought to be at fault, although it was impossible to see how they could cause any disturbance,

Fig. 29

Fig. 32

Fig. 30 Fig. 31

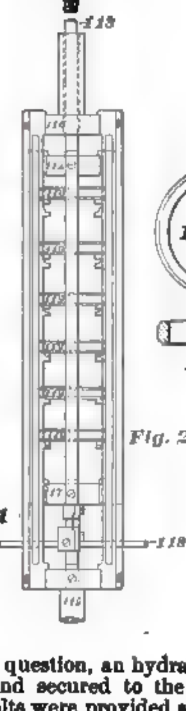


Fig. 28

Fig. 34

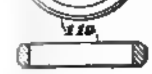


Fig. 33

but in order to avoid any question, an hydraulic chamber 3 ft. in diameter was made and secured to the underside of the platen, and suspending bolts were provided so the platen could be adjusted closely to place by the screws and all lost motion taken up by the suspending bolts; pressure was applied by pumping liquid into this hydraulic chamber. The results differed in no way from those previously obtained, but by

this time I had determined what the cause of the trouble was —namely, that we had been trying to weigh two kinds of pressure without thinking that they might have different results. I therefore coupled this hydraulic cylinder to a testing machine scale, applied a pressure of about 150,000 lbs. on the platform of the support testing machine, and put weights on the poise frames of the testing machine scale until its needle stood at zero. We then ran the ton weight on, and, as I expected, the needle on the scale immediately moved, indicating a reduction in the pressure. This reduction was produced by the very minute sinking of the platform when the ton weight was applied. Keeping the weight on, the screws were adjusted until the needle stood again at zero, and then the ton weight required exactly the same amount to balance it as when it was put on the empty machine. This settled the whole question; we found the machine was right, its weighings regular under conditions of distortion that would have ruined an ordinary scale, and that the whole trouble came from the fact that we had been trying to weigh screw pressure and pressure produced by gravity without taking into account the disturbance that one produced on the other.

The extreme sensitiveness of this machine serves to show how material supposed to be solid and rigid is in reality continually in motion. In one test the full pressure of 500,000 lbs. was put upon the platform and allowed to remain for 70 hours. At the end of this time it had fallen off to 498,407 lbs., and the falling off still continued at a rate of about 1 lb. in 10 minutes. The pressure was then reduced to 400,000 lbs. Instead of falling off the load increased 40 lbs., in three minutes, and after standing for 10 minutes the load decreased at the rate of 7 lbs. in about five minutes. When the pressure was reduced to 300,000 lbs., in nine minutes the load increased 146 lbs.; with no further indication of increase or decrease for 11 minutes, when it began to fall off very slowly. The pressure was then reduced to 200,000 lbs. In five minutes it increased 307 lbs., and in nine minutes 870 lbs. At this point the load began to fall off very slowly.

It would be very interesting to try if any lapse of time under load would finally bring these movements to rest, but there has been as yet no necessity for making the experiment.

DISCUSSION.

It was asked whether it required the operation of more levers than one to operate the scale. In the old machine it requires one lever for each weight clamped.

Mr. Bancroft: There is one lever for each weight clamped in this. Each frame has a lever which is provided with this click spring. In this scale here each weight is indicated by a small indicator. On the regular testing machine we group those all together, so that the total consumption of the weight is weighed in one line.

Mr. Albert Emery: When this load of 500 was put on and remained 70 hours, I suppose it was a solid loading of metal to metal.

Mr. Bancroft: It was a solid loading of metal to metal.

Mr. Henry R. Towne: I think it might assist the meeting and prevent a misunderstanding if a point made by Mr. Bancroft at the close of his remarks were explained—namely, that the experience with this machine had developed a difficulty due to the difference in pressures resulting from loads applied by gravity or the screws. It is simply this, that the load is applied through the action of these screws, producing tension in these stays or rods and compression in other parts of the machine. Now when a weight, say, of 1 ton is added to the load on the platen, it tends to substract that amount of load from the strain which is upon the other parts of the machine. It takes it from the tension of these rods and off from the compression of certain other parts, and it is that diminution of the pressure acting on the material of the machine which distributes the resistance of the material to that particular pressure. The pressure is lessened and the elastic action of the parts under the altered pressure is somewhat different from what it was before. The application of the additional load changes the tension or the compression, as it may be, upon the component parts of the machine, and the means of recording that elasticity is so remarkable that it appears on the reading of the scale.

Mr. Bancroft: You can understand it probably better if you consider the machine, instead of being supported on the base, as being suspended on the upper cross-head. Then these columns would have the strain due to the weight of the machine and also the elastic pressure of these rigid blocks between these two platens. Assuming a ton weight put on this platform, it is clear you have thrown an additional stress on those bolts. They must elongate, and that elongation will diminish the pressure between these surfaces to the same extent.

Mr. Albert Emery: I would like to remark that I found the same thing in the original testing machine where I laid down the beam forming the bed; laid on that the beam which forms the platform of the fulcrum or scale. A large standard weight was then to be applied to the beam forming the platform, with an exact load of its weight on the measure on the scale; then long bolts running through those two beams and bolting them together were put under a load of, say, 100,000 lbs. strain, and that we carefully balanced and then the standard weight laid on again. I found that no load that I could put on those bolts, which were able to carry the 800,000 load of the scale, would be retained on that scale perfectly that length of time. That is to say, whether I put on 10,000 on those bolts or 100,000, or 20,000 or 500,000, it was immaterial. No load would stand still. They were always yielding, and I had to give up that method and take another one.

Mr. Bancroft: You see we were forced into the same thing.

Mr. Emery: Exactly, because I was not there to tell you.

Mr. Towne: Mr. Emery was the first discoverer of the fact that there is no such thing as rigidity of material.

Mr. Emery: I would like to add to that remark another one. I have several times conceived the desirability of taking a single bar to form a measure of the friction put on the specimen, measuring the length of the bar when put under compression or tension by strain on the specimen, and recording that length very minutely. But the experience gained in testing this machine, as well as that formerly gained in the original machine, would indicate that the drawbar will never give proportionately to the loads put on it. It will be subject to a very sensible and material error compared to any error of this machine.

A NEW PHOTOGRAPHIC PROCESS.

The London *Times* some time ago gave the following account of an interesting exhibition at the Camera Club, to demonstrate a new method of photography, by means of which several difficulties and drawbacks are easily overcome. The process is the invention of Mr. Arthur Burchett, who gave in the evening, before a large audience, a demonstration and explanation of the system, by which he has obtained such excellent results. The difficulties which he has succeeded in overcoming, as he said, almost by a happy accident, are chiefly those which have, to a great extent, hitherto stood in the way of most photographers—namely, the translation of the colors of nature into correct monochrome values. The discovery is equally important whether it is applied to landscapes taken direct or to the reproduction of original pictures. It is well known that the latter forms to-day an immense industry, if, indeed, it may not justly be called an art, by means of which photography has become almost the only medium of illustration. Not only so, but the reproductions also of the works of the great painters of all times are widely distributed and made easily accessible. It is therefore of great importance that the originals should be correctly rendered in the translation from color to monochrome; and, although there are already a certain number of capable men, the very simple process which Mr. Burchett has placed before us can scarcely fail to benefit a wider section of photographers, both from its application to this class of work and also to photographs taken direct from nature.

All photographers are aware that certain colors have a greater effect upon the sensitive plate than others. The actinism of blue rays and of the sky, for instance, is so great that it is extremely difficult to prevent their action from being buried during development before the effect of less actinic rays can be brought out. On this account the practice of using two negatives, in order to produce a combination print of sky and landscape, is almost universal. Objects of a yellow color, again, are distinguished in the print by a much lower tone than they should have according to their relative value in the natural scale, and the whole system of tone-rendering has long been considered by painters as a reproach to photography. To remedy these defects it has been customary to interpose screens of a yellow color between the object and the sensitive plate, but Mr. Burchett has discovered that a combination of yellow and green screens or glasses is a more effective and simple remedy. The method possesses also other advantages, among which may be mentioned the cure of halation. The whole of this very simple discovery consists, then, in the use of this combined screen. There is, in fact, little more to describe, but a visit to the exhibition and inspection of Mr. Burchett's pictures will at once demonstrate to photographers its importance and value. We have here landscapes

LOCOMOTIVE RETURNS FOR THE MONTH OF DECEMBER, 1893.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage. Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Av. Train. Passenger Cars.	Freight Cars.	Coal Burned per Mile. Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Cost per Locomotive Mile. Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Cost per Car Mile. Passenger.	Freight.	Cost of Coal per Ton.
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Atchison, Topeka & Santa Fé																									
Canadian Pacific	617	617	492,480	680,124	286,631	1,459,295	2,865						80.80			3.41	12.46	0.36		5.71	1.54	23.50			3.09
Chic., Burlington & Quincy	542					1,561,587	2,881	4.97	18.65				95.14			4.33	6.75	0.26	0.38	7.08	0.07	19.81			1.41
Chic., Milwaukee & St. Paul	854					2,457,945	2,878						88.87			3.37	8.46	0.28		6.66		19.47			2.48
Chic., Rock Island & Pacific	564		474,847	964,892	396,163	1,786,901	3,168			69.77	86.77	48.69	68.41			3.18	7.25	0.36		6.22	0.40	17.31			2.06
Chicago & Northwestern	1010		802,513	1,546,308	649,878	2,998,694	2,969						99.45			3.46	9.19	0.31		6.33	0.62	20.10			1.88
Cincinnati Southern																									
Cumberland & Penn *	24	28	5,639	31,191		36,880	1,601						88.93			5.71	4.19	0.35			2.06	12.31			
Delaware, Lackawanna & W. Main L.	211	188	70,600	199,308	358,463	628,371	3,342						108.56			2.81	7.82	0.39		6.11		17.13			1.65
Morris & Essex Division	162	162	173,829	152,449	98,912	424,476	3,619						74.02			5.15	11.48	0.33		5.55		28.51			3.08
Hannibal & St. Joseph	67	67				262,765	3,981	4.84	16.25				96.78	14.70	7.44	1.91	6.50	0.70	0.30	6.26	0.02	15.09			1.45
Kansas City, F. S. & Memphis	147		94,064	219,111	100,386	413,561	2,813						71.82			2.93	6.09	0.23	0.47	7.37		17.09			1.65
Kan. City, Mem. & Birm	42	40	38,004	67,283	11,354	116,641	2,916						69.11			2.29	3.83	0.33	0.26	6.94		13.67			1.07
Kan. City, St. Jo. & Council Bluffs	36	36				132,980	3,694	4.95	20.98				77.67	14.45	5.44	2.14	7.78	0.15	0.37	6.16	0.04	16.66			2.06
Lake Shore & Mich. Southern	591		486,063	863,575	435,740	1,727,377	2,923			73.80	96.06	47.01	72.29			2.86	5.98	0.07	0.12	6.88	0.17	16.10			1.55
Louisville & Nashville																									
Manhattan Elevated		296	778,947		66,973	840,220	2,838						45.87			2.10	6.80	0.20		9.10		20.20			2.63
Mexican Central	148	122				887,907	3,178						72.23			6.06	14.16	0.43	0.19	4.89	0.08	25.92			4.30
Minn., St. Paul & Sault Ste. Marie	106	90	89,694	119,838	27,449	236,981	2,633	4.80	15.75				89.88		6.39	4.80	14.79	0.27		6.63		26.49	4.98	1.75	3.61
Missouri Pacific	351					1,015,835	3,455	4.47	16.18				94.36			4.60	6.63	0.33	1.25	6.25	1.31	20.36	3.74	1.40	1.38
Mobile & Ohio	107	89	75,644	180,192	61,313	317,349	3,565						78.60			2.96	5.30	0.22	0.56	5.36	0.82	15.14			1.43
N. O. and Northeastern																									
N. Y., Lake Erie & Western	687	419	480,771	860,346	264,582	1,555,699	3,713	4.50	22.50	96.90	147.80	65.40	109.37	21.40	8.60	5.10	8.28	0.38	2.34	7.43	1.21	24.68			1.36
N. Y., N. H. & H., Old Colony Div.			482,762	176,628	218,885	878,275		3.80	15.60				67.68	18.00	6.40	8.36	10.15	0.66		7.13	0.68	22.16			
N. Y., Pennsylvania & Ohio	267	182	137,329	424,449	124,315	676,093	3,714	5.90	16.80	86.70	127.10	79.85	97.71	16.80	7.60	4.85	6.15	0.31	2.91	6.87	0.96	22.07			1.10
Norfolk & Western, Gen. East. Div. †			94,283	251,244	53,783	398,350	2,444	5.20	21.40	51.22	141.17		97.74	10.42	6.61	5.41	4.09	0.29				9.79			
General Western Division †			98,636	295,756	45,761	440,156	2,651	5.66	17.12	84.00	186.00		128.00	15.16	8.56	7.91	4.62	0.27				12.70			
Ohio and Mississippi																									
Philadelphia & Reading			423,680	293,956	966,861	1,684,497							87.29			4.95	4.76	0.31		5.76	0.42	16.21			
Southern Pacific, Pacific System	736	683	626,914	679,226	245,969	1,554,102	2,112	5.43	13.81				64.02			5.42	15.79	0.30	2.27	7.24	1.27	33.19			4.66
Union Pacific																									
Wabash																									
Wisconsin Central	149	105	115,116	172,249	50,425	337,790	3,264						98.24			3.11	10.56	0.21		7.23		21.11			2.24

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars. Empty cars which are reckoned as one loaded car are not given upon all of the official reports, from which the above table is compiled. The Union and Southern Pacific, and New York, New Haven & Hartford rate two empties as one loaded; the Kansas City, St. Joseph & Council Bluffs and Hannibal & St. Joseph Railroads rate three empties as two loaded; and the Missouri Pacific and the Wabash Railroads rate five empties as three loaded, so the average may be taken as practically two empties to one loaded.

* Switching engines allowed 6 miles per hour; wood, construction and gravel trains, 10 miles per hour.

† Wages of engineers and firemen not included in cost.

combined with skies, to which a comparatively long exposure has been given, the blues and the various tints of the clouds assuming their true relation of tone; more unusual still, in photography, we have the full disk of the sun appearing as it appears in nature. With ordinary methods what is termed reversal causes the image of the sun to come out black in the print. Snow landscapes and mists, the greens and yellows of ferns and other vegetation are equally subject to correction under the new treatment, and, generally speaking, the effect of atmosphere is far more easily obtained. With regard to Mr. Burchett's reproductions of paintings, several of which, after well-known artists, are exhibited, it will be sufficient to say that the painters themselves are satisfied; no higher testimonial of the value of the process could be given.

With regard to the practical working of the invention, this consists simply in interposing screens of green and yellow glass between the combinations of the lens. The exposure required is increased by very little, and no special plates or special treatment in development are necessary. It is curious to observe also that the screens appear to have the effect of increasing the quality of the definition, so that a lens working with an aperture of, say, *f*22 will give the effect of using an aperture of *f*40. In his early experiments Mr. Burchett found that a yellow glass alone had little or no effect. A green medium was a decided improvement, but the blues were still defective, and the reds also, though to a less degree. By placing, however, the yellow screen in a certain position behind the green the correction is accomplished. It should be noted that a special kind of green glass is necessary; any tint of green will not suffice.

In the discussion which followed Mr. Burchett's lecture, at which Captain Abney presided, the theory of the process was fully entered into by the president and Mr. T. R. Dallmeyer. It must be conceded that an absolutely new process is due to Mr. Burchett; and in photography especially it is of value to establish priority of discovery. Photographers will not hesitate to thank the discoverer for placing within the reach of all a process as valuable as it is simple.

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

The object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publication will in time indicate some of the causes of accidents of this kind, and help to lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with information which will help to make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we all intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in February, has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS IN FEBRUARY.

South Bethlehem, Pa., February 1. — Walter Blank, a fireman on a Lehigh Valley engine, was caught between the tank of an engine and a door-jamb this morning, and squeezed about the hips.

Montreal, Canada, February 2.—Two freight trains collided on the Grand Trunk Railroad at Warwick to-day. The fireman of one engine was seriously injured.

Winamac, Ind., February 4.—A freight train on the Pan Handle Line ran into the rear end of another freight on a crossing near here early this morning. Bruce Ide, the engineer, had fallen asleep and was so seriously injured that he will die. Fireman Merrill was thrown 50 ft., but not seriously injured.

New York, N. Y., February 4.—Frederick Groesbeck, a fireman on the Third Avenue Elevated Road, fell from his engine to-day. He was standing in the side-door when the swaying of the engine made him lose his balance. He fell on the middle track, and received a scalp wound, and several bruises about the body.

Bloomington, Ill., February 6.—An engine on the Chicago & Alton Road blew out a plug from the boiler head 2 miles south of Nillwood this afternoon. Charles E. Drake, the fireman, who was stepping off to shovel coal, was blown out of the gangway and out of the engine. The engineer, Bob Hawks, was scalded about the right hand and other portions of his body. The fireman, besides being scalded on the face, arms, and legs, has severe cuts on the face received by falling on the ballast. His tongue was bitten half in two by the fall.

Columbus, O., February 6 —The last sleeper on the vestibule on the Pennsylvania Railroad jumped the track near this city to-day. The whole train was derailed and the fireman, James Jenkins, was injured.

Doyleston, Pa., February 6.—John L. Hogan, traveling engineer for the Philadelphia & Reading Railroad Company, was struck by a light engine while walking up the tracks this morning. He was picked up in an unconscious condition, and an examination showed his shoulder to be dislocated and his jaw-bone broken. It is also thought he was injured internally.

Burlington, Vt., February 7.—A collision occurred between a freight and passenger train on the Vermont Central Road near here to-night. Engineer Soules, of the freight engine, saw the passenger train come on to his track in time to put on the brakes and jump. He was hurt about his knees, although not seriously. Fireman Mahoney, of the passenger train, was slightly hurt on the side. Fireman James McDougall, of the freight, was hurt in the right hip. Barney Meagan, engineer of the passenger train, was cut over the eye, side of the face, side, and had left shoulder hurt.

Whiting, Ind., February 9.—An express train on the Baltimore & Ohio Road ran into a load of brick standing on a siding, but too near the main track, at this point to-day. T. D. Moore, engineer, was bruised about the head. D. W. Linville, fireman, was hurt about the shoulder.

Lancaster, Pa., February 9.—John Hook, fireman on the Pennsylvania Railroad, had his shoulder wrenched to-day while putting in engine grates which had fallen out of place.

New Orleans, La., February 10.—A collision occurred on the Texas & Pacific Railroad this morning about 140 miles east of this city. The engineer of the east-bound train had orders to meet another train at Rosa. For some reason he ran by Rosa at full speed into the west-bound train. Engineer Penniston, of the east-bound train, was killed.

Great Bend, Pa., February 10.—Moses Conrad, a fireman on the Delaware, Lackawanna & Western Railroad, while dumping ashes off an engine, was struck by the lever and very seriously hurt.

Philadelphia, Pa., February 10.—H. C. Call, an engineer on the Philadelphia & Reading Railroad, was leaning out of his cab and was struck by a freight car on an opposite track in the city to-day. He was so seriously injured that he died from the effects of his wounds.

Buffalo, N. Y., February 11.—Albert King, an engineer on the Lehigh Valley Railroad, fell off his locomotive in the yards at East Buffalo this morning and broke his left arm in two places.

Fremont, O., February 12.—Two freight trains on the Wheeling & Lake Erie Railroad came into collision about 2 miles west of Belleville this morning. Engineers Connell and Stowell of the two engines were killed. Fireman McMullen, of one engine, was also killed. The blinding snowstorm hid the signals, which resulted in the collision.

Temple, Kan., February 12.—A switch engine on the Atchison, Topeka & Santa Fé Railroad exploded its boiler to-day. Engineer Coleman and Fireman Cheatham were injured. Cheatham was badly scalded, and had his right leg cut off. There is no hope for his recovery.

Los Angeles, Cal., February 16.—Train robbers held up a train on the Southern Pacific Railroad near Roscoe to-day. The train was stopped by a flaring of a torch showing an open switch. The engineer jumped and ran and escaped with a sprained wrist and some scratches about the legs. The locomotive jumped the track, and the fireman, Masters, was pinioned in between the cab and the tender and horribly mutilated, crushing his legs.

Des Moines, Ia., February 17.—A collision occurred between a freight train and a passenger engine on the Chicago, Rock Island & Pacific Railroad, near Valley Junction, this morning. The engineers, George Lair and James Wolf, were seriously injured. Fireman Myers was, it is thought, fatally hurt.

Huron, S. D., February 19.—An east-bound express on the Chicago & Northwestern Railway was thrown from the track to-day by a broken rail. George Coon, engineer, and James McNicholl, fireman, were slightly scalded.

Hyde Park, Mass., February 24.—There was a break on one of the engines on the Providence Division of the New York, New Haven & Hartford Railroad to-night, and the fireman was slightly injured by one of the flying pieces.

Kaukauna, Wis., February 27.—An engine on the Chicago

& Northwestern Railroad broke a side rod at Cleveland this morning, shattering part of the cab and injuring R. R. Powers, fireman. Engineer Thomas Gray also had his arm injured.

Bellaire, O., February 28.—A freight engine on the Baltimore & Ohio Railroad exploded its boiler at Nuzum's Mills, W. Va., this morning. Engineer Stevenson and Fireman Law were terribly injured.

Our report for February, it will be seen, includes 22 accidents, in which five engineers and two firemen were killed, and 13 engineers and 17 firemen were injured. The causes of the accidents may be classified as follows:

Blowing out plug	1
Boiler explosion	2
Broken rail	1
Broken side-rod	2
Caught between engine and tender	1
Collision	7
Derailments	1
Falling from engine	2
Repairing grates	1
Struck by ash-pan lever	1
Struck by engine	1
Struck by obstruction	1
Train robbers	1
	22

BUILDING STONE FOR ENGINEERING STRUCTURES.

The following extracts are from an interesting paper by W. B. Ruggles, C.E., which will interest many readers who are obliged to assume the responsibility for the endurance of engineering structures which are either built in whole or in part, or rest on foundations of that material. The author of the paper says:

"The exhibit made by the census of 1890 shows that the value of building stone quarried in the United States in 1889 was $53,000,000. By the census of 1880 it appears that the value of the corresponding products in this industry in 1879 was only $18,000,000, Ohio at that time ranking first. In the exhibit of the United States Geological Survey in the Mines Building, at Chicago, was a pyramid showing the volume of mineral substance produced in the United States every second. The greatest is bituminous coal, a cube 4.5 ft. each way, of limestone, a cube 204 ft. on each line, and of sandstone, one of 8¾ in. on all lines, were shown. By the report of the Railroad Commissioner in 1891 it is shown that the railroads of Ohio transported 3,500,000 tons of stone and similar material that year.

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"For the uses of an engineer the hardest stones are not always the best. The principal down-town thoroughfares of Cincinnati were paved with granite from quarries near Richmond, Va., but it was thought that this stone wore too little, or was rather polished than worn by the traffic to which it was subjected, and the intersections of Fourth Street were relaid with Georgia granite, which subsequently came into general use for the streets. There are other members of the Society who can give the merits of the two varieties. The published tests for crushing strength show from 68,000 to 84,000 lbs for 2-in. cubes of Richmond granite, and from 77,000 to more than 85,000 lbs. for similar cubes of Lithonia (Georgia) granite, specimens not being crushed at 85,000 lbs., the limit of the capacity of the Navy testing machine at Washington. The Lithonia is reported as a normal granite, composed of quartz, mica and feldspar, with a very low percentage of absorption and free from discoloring matter. In this connection the writer wishes to refer to a statement made to him by Colonel Fladd, then President of the Board of Public Improvements at St. Louis, as to one result of tests made by him on blocks of the Missouri granite from the Gratz Brown quarries. The experiments showed that a wear equal to that on the busiest streets would not reduce an ordinary paving block more than one-twentieth of its depth in 20 years.

"Of less interest to the engineer than to the architect are the stones of darker shades that come from remote quarries. It will be of interest, however, to note that the Carew Building is trimmed with a Lake Superior red stone. The trimmings of the Cleveland, Cincinnati, Chicago & St. Louis Railroad Company offices on Third Street, lately erected, are of West Virginia brown stone, the Greenbrier brown stone, which is used also in the Young Men's Christian Association Building. It is quarried near Hinton, W. Va., and is a stone of attractive shade, but so exceedingly hard as to be expensive to work. It is reasonable, however, to suppose that this excessive hardness gives it its unusual crushing strength, which is reported as 150,000 lbs. per square inch. Its weight is given as 165 lbs. per cubic foot and absorption as one-half of 1 per cent. of weight. The Chamber of Commerce is built of granite, sometimes called 'Quincy granite,' but quarried at Worcester, Mass.

"There is a Killbuck sandstone of pink and brown shades used in a number of Cincinnati buildings. Of this a sample is shown.

"The first bridge erected over the Ohio River at Cincinnati was the Supension Bridge, completed in 1867. The piers of that structure, begun in September, 1856, are, as noted above, built of Buena Vista freestone backed with limestone from North Vernon. In restoring injured cables Mr. Bouscaren, a member of this Society, stated in the paper which he presented to the Society a year or more ago, that much of this masonry had to be torn away to provide for the enlarged cable. His comment on the character of the masonry is that it was poorly laid, but as he does not speak of any deterioration of the stone, it is fair to presume that the interior of the structure was in a tolerable state of preservation. The height of these towers is 230 ft. above low water, or 242 ft. above timber foundation.

"The next bridge constructed was that known as the Cincinnati and Newport Bridge, in 1872. This was built largely of Buena Vista stone from those quarries, particularly the shore piers. The river piers are chiefly limestone from quarries near North Vernon and Greensburg. In these piers this stone has shown a disposition to crack and check. The masonry here, however, may in part be reconstructed with the reconstruction of the bridge proper, the traffic having outgrown the capacity of the whole structure.

"The third bridge was that of the Cincinnati Southern Railroad, completed about 1875. The piers of that bridge were constructed of stone from the Holman Indiana quarries on the Louisville branch of the Ohio & Mississippi Railroad. The piers give no evidence of failure.

"The fourth bridge was that of the Chesapeake & Ohio Railroad, completed in 1888. It is built of Kentucky freestone, probably from near Morehead, and oolitic stone from Salem, Ind., which Mr. W. H. Burr reports as offering a compressive resistance of 12,000 lbs. per square inch, and a ratio of absorption not exceeding 2 per cent. The Kentucky freestone used in the piers is credited with a resistance of 15,000 lbs. per square inch. The Ohio shore pier is built entirely of Ohio River freestone. The river piers are faced with Greensburg limestone backed with Ohio River freestone.

"The last bridge completed is that of the cantilever known as the Central Bridge between Cincinnati and Newport. The piers of that structure of stone are mainly of the Ohio River freestone coped with Bedford oolitic limestone. In the river piers, however, the lower courses of two are of Berea sandstone, and of three of Ohio River freestone with concrete backing up to the belting course, and finished with Ohio River freestone with a coping of Bedford limestone. The reason for this miscellaneous construction is given by Mr. Kaufman, in his paper on that bridge, as follows: 'Considerable difference of opinion as to the reliability of limestone obtainable in quarries near Cincinnati for backing is found among engineers in Cincinnati; but there was no time to investigate, and other quarries were not able to furnish it. There was only available the Bedford stone and the Berea stone, and of these no guarantee of prompt delivery could be made from the Bedford quarries, hence the use of the Berea sandstone. But in the absence of information concerning the comparative elasticity of concrete and Berea sandstone, the use of the concrete filling was not permitted in the higher piers. It is thought that as the Berea sandstone is comparatively soft, if the concrete would compress more than the stone did, an undesirable strain would be thrown upon the facing course of sandstone.

"The first bridge above Cincinnati over the Ohio is at Kenova. Its piers are of Otway stone.

"It will be interesting to note the calculations of engineers as to the amount of strain that stones take in these structures. It is difficult, from the report just quoted on the Central Bridge, to determine the exact weight of the lower courses of the river piers, owing to the form of the cantilever, but it is probably over 2,020 lbs. per square foot for the fifth and sixth piers. Mr. Burr states that the load for the pier of the Chesapeake & Ohio bridge on the Ohio side is 77,200 lbs., and on the Kentucky side 81,200 lbs. for each pile. The load of the river pier, Ohio side, is 13,000 lbs. per square foot, and of the Kentucky River pier 13,047 lbs. per square foot. The writer is unable to get exact figures of the old Newport bridge. The weight coming on the pedestals under the ends of the

main channel span of the Cincinnati Southern Railroad is between 48,000 and 49,000 lbs. per square foot, but these pedestals are of superior stone.

"For purposes of comparison are given the weight on bottom courses of piers of the Sibley Bridge over the Missouri, which is 12,000 lbs. and more per square foot, and of the Chicago, Burlington & Quincy bridge at Plattsmouth over the same river, where the pressure per square foot ranges from 100 to 6,400 lbs., and the pressure per pile, for the river pier at 27,000 lbs. per pile. In his lately completed Memphis bridge, George S. Morison estimates the weights of the two river piers as 10,410 and 9,934 lbs. per square foot respectively, but after deducting buoyancy, friction, etc., the pressure on the clay foundation is placed at 8,839 and 3,503 lbs. per square foot. This clay resists compression on an average at one pier of 13,400 lbs. and at the other of 19,300 lbs. per square foot.

"Several years ago Colonel William E. Merrill and John W. Hill were consulted concerning repairs of the Eden Park Reservoir wall. There was some disagreement between them as to the strain that would be thrown upon certain courses in the masonry, the principal difference being as to what were the existing conditions. Mr. Hill's supposition was that the moisture of water sweeping through cracks and crevices would reduce the underlying soil to a state of soft mud, and in that event there would be a pressure at the water side of the wall of 190,000 lbs. per square foot. Colonel Merrill's opinion, however, was that it was improbable that the soil would be reduced to the condition supposed by Mr. Hill.

"The weights coming at the bottom of the masonry in piers of the Suspension Bridge is 7,750 lbs. per square foot, and on the plates under the saddles probably more than 20,000 lbs. per square foot. It is not easy to determine from the report just what the maximum weight might be. In this connection it will be of interest to note that L. L. Buck, who replaced the stone towers of the Niagara Railway suspension bridge with iron towers, calculated that the weight on the rollers of that structure would cause a pressure of 36 tons per square foot on the masonry. Whatever the pressure, it resulted in the destruction of the masonry, which was built of stone from a local quarry. The plans of Messrs. Hogê & White show that the maximum pressure in their arch over Wheeling Creek (Wheeling, W. Va., referred to above) is 533 lbs. per square inch.

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"The increased demand for building stone has led to improved methods of quarrying, and probably the reverse proposition is true also. Usually these stones occur in strata that are broken by cross seams, and the value of the stone for building purposes depends not alone on the material construction of the stone itself, but upon the form in which it can be readily quarried. One of the advantages of the Otway quarries and of the Bedford quarries is that practically any sized piece can be quarried that can be handled. The Knox system, which depends for its principle upon the peculiar form of the drill holes, has reduced the cost of such work materially, and in connection with the electric blasting and the use of channelling machines is leading to large reduction in the cost of the stone at the quarries. Figures are quoted of the cost of quarrying iron ores, which, as a rule, are difficult to remove, at a trifle over 72 cents per cubic yard. The usual price for excavating rock in railroad graduations is 80 cents per cubic yard. The cost of the Government work on the Harlem River was about 40 cents per cubic yard, and the cost of open cut work is stated on good authority to be from 3 to 10 cents for drilling, and from 15 to 30 cents for blasting and excavating. These figures should apply closely to ordinary stone quarrying. Any structure which is intended to be permanent, as such affairs should be considered, is usually built of stone, and it is important that in selecting material for a permanent structure material be chosen that will not only sustain the weights and carry the loads to which it will be subjected, but also stand the effect of water, by which is meant the effect of freezing and thawing, and also of gases which abound especially about cities. Several years ago a very able paper was written by Dr. Thomas Eggleston, of Columbia College, on the cause and prevention of decay of building stone, and for the information of the members of the Society the liberty of referring to some statements in that paper is taken.

"One interesting fact stated by him is that in the purest air carbonic acid exists to the extent of about three one hundredths of 1 per cent. only; but that in and about cities, especially those where coal is used in abundance, this amount is greatly increased; and other authorities are quoted as giving as the result of experiments made by them, that the heat is increased by the reason of the increase of this gas in the winter months. The estimated value of a London winter's smoke is set down at $25,000,000. New York City is said to use in the neighborhood of 5,000,000 tons of coal per year. The imports of coal in Cincinnati in 1890 were 2,500,000 for local consumption. From this at least 35 lbs. of sulphuric acid would be discharged in the air for each ton. This must have its effect upon the stones of buildings. The act of freezing is equivalent, in his opinion, to the blow of a 10-ton hammer. To such causes as this, leading to the disintegration of stone, he adds that of efflorescence upon, or the formation in the stone itself, of soluble salts, and the corroding effect of sand carried by wind at a high velocity.

"It follows that stones which are to be used in structures should be carefully observed as to whether they contain minerals which are already decomposed or are likely to become so. Dr. Eggleston states that stones which are subject to no decomposition apparently in one climate are thoroughly decomposed in others. For instance, he was led to conclude from his examination that limestones are entirely unsuited in the climate of New York for the construction of monuments and buildings to be exposed to the air. Sandstones having a silicious binding are the most durable; those in which the binding material is the oxides of iron usually disintegrate readily. He says, also, that while the amount of carbonic acid in the air and water at any time is extremely small, the accumulation of very minute quantities acting over a large area for a considerable length of time has often been sufficient to dissolve out the whole of the binding material. There is a difference between stone newly quarried and that which has been exposed for sufficient time to lose its quarry water. A good specification for masonry should be to require such seasoning—an ancient practice of architects. It is said to have been required by Sir Christopher Wren that the stone for St. Paul's Cathedral should season for two years before being taken from the quarry. It is, however, urged that the stone should be reduced to its proper dimensions as soon after quarrying as possible. For good sandstone and limestone a serious source of disintegration is from freezing and thawing. The writer has frequently been reminded of this in looking out of his window upon the Masonic Temple, which was built of Buena Vista stone, begun in 1858 and finished probably in 1861. The stone in that building is in a good state of preservation, except about the water spouts and places near the roof, where the ice accumulates in freezing weather. This is probably aggravated by placing the facing stone on edge rather than on its quarry bed—at least the appearance of the stone leads to that conclusion. Nearly all varieties of stone will crush on edge with less load than on their quarry bed."

MARINE NOTES.

Boilers for the "Powerful" and "Terrible."—The Admiralty will fit the *Powerful* and *Terrible* with boilers of the Belleville type. The *Armand Béhic* and *Polynésien*, two large steamships of the French-Australian line, are fitted with the same type of boilers. These are 10,000 H.P., and are reported to have made faster runs than any British ship of similar tonnage. It is as a consequence of the success with these two ships that the Admiralty have decided to try the same boilers on the two large cruisers that are about to be built.

Electric Gondolas in Venice.—The success of the electric gondolas at the World's Fair has encouraged the builders to reciprocate the compliment which was paid to the United States by Venice, in sending an exhibit of gondolas for the lagoons, by sending an electric launch driven by storage batteries to Venice. Another curious exemplification of the utility of the storage battery is shown in the case of the use of a copper-steel alkaline battery of 384 cells, which draws its current from the street railway circuits, and is used to drive two Waddell-Entz motors of 40 H.P. each, that swing the 520 ft. span bridge of the Omaha Bridge & Terminal Company. The draw weighs between 3,000,000 and 4,000,000 lbs., and is swung in about four minutes.

British Battleship "Centurion."—There are some new and interesting features about the new British battleship *Centurion*, which has just passed through her official trials at Portsmouth. The vessel herself belongs to a new type, there being only one other like her—the *Barfleur*. She is 360 ft. long and 70 ft. broad, with a displacement of 10,500 tons. A belt of steel armor, having a maximum thickness of 12 in., protects the water-line for about 250 ft. of her length, and extends below water to a depth of 5 ft., and above water to a height of 2½ ft. Associated with the belt is a protective deck from 2 in. to 2½ in. in thickness, which is completed at the ex-

tremities by athwart armored bulkheads 8 in. in thickness. The armament consists of four 10-in. 29-ton guns mounted in redoubts; ten 4.7-in. quick-firing guns, of which four are carried in armored casemates; eight 6-pdr. and nine 3-pdr. Hotchkiss quick-firing guns; a complement of field and machine guns, and seven torpedo tubes, two being submerged. The heavy guns are contained in redoubts, which are neither turrets nor barbettes, but may be described as turrets revolving within a fixed barbette. The guns can be loaded at any angle of training, and can be worked either by steam or hand power. Moreover, owing to the arrangement of the shields, they command a range of 42°, without unduly large ports. There are also several new and ingenious devices for insuring a rapid and continuous supply of ammunition. Owing to novelties in construction, the ship was subjected to severe trials which are said to have resulted most satisfactorily. It is announced that hereafter the 50-ton gun will be the largest employed in the British Navy.

Foreign Torpedo Boats.—A correspondent of the London *Times* writes: "The following are particulars of the sea-going torpedo boat *Forban*, which is now being built at Havre by MM. Augustin Normand & Co., and which is designed to attain the extraordinary speed of 30 knots, or 34¼ statute miles an hour: Length, 144 ft. 3 in.; beam, 15 ft. 3 in.; draft, 10 ft.; displacement, 130 tons; indicated H.P., 3,200. The vessel will have twin-screws, and will carry two torpedo-ejectors and two 1.46-in. guns. The *Forban* will be by far the fastest craft afloat. The *Chevalier*, a torpedo boat of the same length, but of only 2,700 indicated H.P., was recently delivered by MM. Normand, and has attained a speed of 27.22 knots.

"The boilers which give these striking results are a specialty of the firm of Normand, and are, it is understood, to be adopted for the new British torpedo boat destroyers *Janus*, *Porcupine*, and *Lightning*, under construction by Messrs. Palmer & Co., of Jarrow, and for the *Rocket*, *Shark*, and *Surly*, under construction by Messrs. J. & G. Thomson, of Clyde Bank.

"Of the numerous sister ships that have been ordered, the *Conflict*, *Teazer*, and *Wizard*, building by Messrs. J. S. White, of Cowes, are to have Mr. J. S. White's boilers, constructed by Messrs. Maudslay, Sons & Field; the *Fervent* and *Zephyr*, building by Messrs. Hanna, Donald & Wilson, of Paisley, are to have locomotive boilers; the *Swordfish*, building by Sir W. G. Armstrong, Mitchell & Co., is to have Babcock & Wilcox's boilers; and, probably, the *Skate*, *Starfish* and *Sturgeon*, building by the Naval Construction & Armaments Company, at Barrow, and the *Sunfish*, building by Messrs. Hawthorn, Leslie & Co., of Hebburn, will have Blechynden boilers. Yet other vessels of the class will have Yarrow, Thorneycroft, Belleville or Du Temple boilers; so that the trials of the destroyers should afford a fairly good indication of the merits of the various British and French systems.

Electrical Canal-Boats.—The Cataract General Electric Company has secured a permit from the Superintendent of the State Department of Public Works for the privilege of putting in an electric plant along the lines of the State canals by which boats may be operated with electricity. The permit authorizes the Company to enter upon all lines of the State for the purpose of constructing on, over, or under either canal bank, a system for propelling canal-boats with electricity without interfering with the present mode of operation. A central power-house may be erected. The rate is to be subject to modification and review by the State Superintendent of Public Works, but it is stipulated that the rates shall not exceed $20 per electrical H.P. for any season of navigation. The important provision is that the Company, so long as the wants of the State are supplied, may employ its electric plant along the line of the canal in furnishing electric light, heat, and power for distribution to any point or points beyond the line of the canal, and may thus furnish electricity for lighting and power purposes in all of the cities and villages along the canal. The Company must furnish to the State, free of charge, sufficient power to operate motors to open all gateways leading to and from locks, and also electric lamps sufficient to properly illuminate such locks at night. It is also stipulated that its plant must be in operation on the Erie Canal between Buffalo and Albany within three years, or the privileges accorded by the permit will be forfeited. The Company will obtain its electric power at Niagara Falls from the Niagara Power Company, and will transmit it to Albany along the line of the Erie Canal. There is another company having the same directors as the Cataract Company called the Erie Electric Towing and Power Company, with their principal office in New York. This Company will construct and put in operation as soon as possible a half-dozen tugboats operated by electricity, either on the storage or trolley system, with a view of showing the adaptability of electricity to canal navigation. These boats will also tow for a moderate consideration any horse-boats, the captains of which desire to avail themselves of such methods of navigation.

Test of the United States Dredge "Ram."—The Bucyrus Steam Shovel & Dredge Company, of South Milwaukee, Wis., have recently completed a powerful self-propelling suction dredge for the Mississippi River Commission, and the machine has lately been tested, the actual work fully meeting the requirements which were made upon it. These were that the practical capacity should not be less than 300 cub. yds. of solid matter per hour, when discharging over a bar or bank not less than 10 ft. above the water surface, and with point of discharge not less than 300 ft. distant. The dredge had to be capable of working effectively in stiff clay and sand, of cutting its own way through a solid bank above water, of working in all depths down to 30 ft., of discharging material on either side to a distance of 1,000 ft., and over a bank 35 ft. elevation above bottom of cut, and of admitting easy and rapid handling in a narrow channel in shoal water and in a rapid current. The dredge was built on the Ohio River, and proceeded to its destination in Louisiana under its own steam, making a speed of 7 miles per hour, towing 11 pontoons. The test for capacity took place on January 29, under supervision of Captain John Millis, on the part of the Government, and Mr. A. W. Robinson on the part of the builders. The volume of discharge was measured by diverting the stream into water-tight bins upon a large flat scow fitted with suitable sluices and gates. Samples of the discharge were taken in this way for periods of 30 seconds every half hour during the test. At the conclusion of the test the contents of the bins were allowed to settle undisturbed for 40 hours, and the contents accurately measured. Then the water was drawn off and the residue measured. This residue was found to consist of semi-fluid mud on top and solid material in the bottom, and was therefore measured separately, with results as follows:

Duration of measured trial	3 hours.
Total time pumping into scow	3 minutes.
Total measured volume	70.76 cub. yds.
Volume of residue after settling 40 hours	38.37 cub. yds.
Percentage, residue total volume	54
Rate of discharge of residue, cubic yards per hour	777¼
Volume of semi-fluid mud drawn off after 40 hours	16.37 cub. yds.
Volume of solid matter left	22 cub. yds.
Semi-fluid mud reduced to solid material	9.82 cub. yds.
Total solid material discharged in 3 minutes	31.82 cub. yds.
Percentage of above to total volume	45
Rate of discharge of solid material, cubic yards per hour	636.4

The dredge was making a cut 100 ft. wide and 14 ft. deep, discharging 10 ft. 6 in. above the water at the prescribed distance, and the result, as will be seen, was more than double the guarantee. This large output was obtained steadily, and no attempt was made to sort the material. In this dredge the material is excavated and fed uniformly and continuously to the pump by a rotary steel cutter-head of improved form, so that the pump and pipe is always worked up to its maximum carrying capacity, and the percentage of solid matter under perfect control. The dredge was built from the designs of Mr. A. W. Robinson, the Chief Engineer of the Bucyrus Company.

PROCEEDINGS OF SOCIETIES.

Association Engineers of Virginia.—At the February meeting Mr. C. C. Wentworth opened the meeting with the topic of the evening, which was Highway Bridges. He gave complete tables of weights of trusses and methods of obtaining weights for various loads, also strain-sheet blanks for various forms of trusses, tables of sections from which the approximation for each chord could be obtained. Standard shop drawings were also exhibited showing eye bars, chord members, etc.

Liverpool Engineering Society.—At a meeting on February 14 Mr. Morgan read a paper on Street Pavements, in which he paid more particular attention to experimental pavements and the various kinds that have been laid, with a view to mitigate the noise of traffic, such as asphalt and wood pavements, giving details of their wear and cost, and the comparative merits of different classes of woods used for paving. Statistics were also given showing the relatively greater wear of steel tramways in comparison with granite sets.

Northwestern Railway Club.—At the regular meeting on February 13, papers were read by Mr. George Dickson, of the Great Northern Railway, and Mr. H. L. Preston, of the Omaha Railway, on Steel *versus* Iron Axles for Locomotive and Car Use. Mr. Dickson's paper took up the record of certain axles which have been in use on the Great Northern Road that offered a fair basis for comparison, and was somewhat in favor of steel axles both for safety, convenience, and cost. In the discussion, Mr. L. R. Pomery took the position that an alteration of the structure of iron bringing about a condition similar, if not exactly corresponding to the crystallization, can be brought about by vibration, and gave examples of crane chains and spokes of certain wrought spoke wheels to illustrate his position. Other members advanced the idea that a muck bar axle is preferable to one made from scrap. The subject for the next meeting will be Brick Arches in Fire-boxes, and Care of the Passenger Trains at Terminals.

Engineers' Club of St. Louis.—At a meeting on February 21 there was a discussion in regard to the location of boulevards in the central part of the city, followed by a paper on the Manchester Ship Canal by Mr. John Dean, who gave a synopsis of the plan of reorganization and the work which has been done, and with which most of our readers are familiar. The canal, he said, is 26 ft. deep, 28 ft. on the lock-sills, with a width of 120 ft. at the bottom and 170 at the waterline. It is lighted throughout by electricity, so that it can be used by night and day, and the clearance allowed on the bridges is 75 ft.; the time of passage from six to seven hours. At the meeting of March 7 Mr. L. Holman gave an address on the new St. Louis Water-Works, giving a short *résumé* on the early historical, with the present and future aspects of the work. The first agitation for water-works in St. Louis began in 1829, and they were built between 1833 and 1836 with a wooden reservoir 100 ft. square. The pipes were all of lead and put in by the city. The present system was put into service in 1872, and there are now 420 miles of pipe in the city.

Engineers' Club of Cincinnati.—The report of the Secretary for the year ending December 21, 1893, has just been issued, and contains a list of the papers which have been read during the year, and which were as follows: Country Roads; the Position which their Improvement should Occupy in the Internal Development of the United States, M. D. Burke; Suggestions on the Improvement of the Miami Canal, Major L. M. Hosea; Peculiarities of Numbers, Oswald Dietz; Proposed Plan for Disposal of Overhead Wires in Cities, Colonel Latham Anderson; Sidewalk Improvements in the Vicinity of Cincinnati, E. F. Layman; Underdrainage as a Structural Feature in Engineering Works, Colonel Latham Anderson; Building Stones of the Vicinity of Cincinnati, W. B. Ruggles; Ladies' Night—Reading of selections from the manuscript of "Blennerhassett," Professor W. H. Venable; vocal and instrumental music; Telford *versus* Macadam—Which was Right? Colonel Latham Anderson; Contractors *versus* Specifications, Charles E. Ewing; Construction of the Norwood Reservoir, C. N. Miller. Annual Address: Engineering Progress During the Past Year, Colonel Latham Anderson.

At a recent meeting of the Club Mr. M. D. Burke read a paper on the ship canal from Cincinnati to Toledo, in which he reviewed the question of the construction of a canal of sufficient dimensions to allow the passage of boats and barges of large sizes. He discussed the question from the standpoint of the requirements necessary for a navigable water-way connecting the lakes with the Ohio River, the physical conditions required to make such a line practicable, and the benefits to be derived from its construction.

Civil Engineers' Society of St. Paul.—At a meeting on March 5 Mr. C. J. A. Morris addressed the meeting on the subject of Coal Docks and Coal Handling Plants. He illustrated it by maps, plans, photographs, etc., of the belt railway and coal dock of the Northwestern Coal Railway Company, which is now being built at Superior. The tract of land which it occupies is more than 75 acres, and is being filled to an average depth of 10 ft. It is bounded by cribs of 12 in. square timber hemmed in by a row of 60 ft. piles driven to 4 ft. centers. The cribs are 22 ft. deep, 24 ft. wide, and are sunk in 250 ft. sections with material, principally sand, which has been raised by a hydraulic dredge that is capable of moving 300 cub. yds. of solid matter per hour. The dredge consists of two scows of 5¼ ft. draft connected by a huge joint. The end of a 20-in. section pipe carrying a revolving cutter, which masticates anything in its way except solid rock, ranges vertically 28 ft. and horizontally 80 ft. by the swinging of the smaller scow. The main boat, which is 95 ft. long, is anchored by fore-and-aft spuds. If the dredge is swung from a forward spud a range of 150 ft. is secured. The 400-H.P. engine works a centrifugal pump, and cutter material may be carried through the 18-in. delivery pump for a distance of 3,500 ft.

Engineers' Club of Philadelphia.—At a meeting on March 3 Mr. W. B. Riegner read a description of the New Falls of the Schuylkill Bridge of the Philadelphia & Reading Railroad Company, and Mr. John C. Trautwine, Jr., called the attention of the meeting to an interesting problem which occurred in supplying the village of Frackville from the Mud Run Reservoir in Schuylkill County. The water was fed through a 10-in. pipe, for a distance of 8,000 ft., to locomotives and fireplugs in the village. The fall in the pipe was 40 ft., and the head in the reservoir 20 ft. At the village this pipe separated into two branches 6 in. in diameter, one 3,200 ft. long, running to the village of Mahanoy Plain, with a fall of 340 ft., and the other about 1,500 ft. long, running to the head house of the plain, and in this distance first rising 2 ft., then falling about 10 ft. to the upper story of the head house, and 15 ft. further to the cellar. The difficulty experienced was that, owing to the much greater head in the long pipe, the valley at its end got all the water, leaving practically none for the head house at the top of the plain. Mr. H. K. Nichols, Chief Engineer of the Philadelphia & Reading Railroad, remedied the trouble by the simple expedient of introducing in the long pipe, just below the branch, a siphon about 18½ ft. high, provided at the top with a blow-off cock, by which the air is allowed to escape when it accumulates in too great quantities.

New York Railroad Club.—At the March meeting two papers were read. One by Mr. West, Superintendent of Motive Power of the New York, Ontario & Western Railroad, on "What is an Economical Load for the Locomotive from the Standpoint of the Motive Power and Transportation Departments?" and the other by Mr. Weston, Superintendent of the West Shore, on "From what Class of Employés Should Locomotive Firemen be Selected?" It cannot be said that any real decision was reached in the discussion of either paper. Many instances of overloading and bad practice were cited, but no one offered a practicable remedy. The second paper fared about as badly. Mr. Weston laid down the four following propositions:

"First proposition: The locomotive fireman should invariably be selected from employés engaged in road service.

"Second proposition: Locomotive firemen should be selected from among the men filling the position of head brakeman on freight trains. This proposition anticipates that the position of head brakeman on freight trains shall be filled by men who have been especially selected with reference to their fitness for firemen, and that while they are filling the position of head brakeman they will be on probation or trial for the purpose of ascertaining, as nearly as possible, whether they are the right kind of timber to grow up to be engineers or not.

"Third proposition: In selecting firemen the man's promise of becoming a good runner should be the controlling consideration, and that everything else should be subordinate to this essential requisite.

"Fourth proposition: As a general rule, the fireman who has the least promise of becoming a satisfactory engineer is the one who is selected from the ranks of the engine wipers."

But in the discussion there was a strong exception to taking firemen exclusively from the ranks of the head brakemen, and men ranging from farmers' boys to round-house wipers and helpers were reported as having made excellent firemen.

PERSONALS.

Mr. W. H. Rosing has been appointed Master Mechanic of the First District, First Division of the Denver & Rio Grande Railroad, with an office at Burnham, to take the place of Mr. Quimby Lamplugh resigned.

Mr. Rollin H. Wilbur, General Superintendent of the Eastern Division of the Lehigh Valley Railroad, has had his jurisdiction extended so that it now covers the Northern Division, and after March 5 the superintendents of the North Branch, Seneca, Auburn and Buffalo Divisions report to Mr. Wilbur as General Superintendent at South Bethlehem, Pa.

CONGRATULATORY.—An event of much importance to a number of people occurred just after THE AMERICAN ENGINEER went to press last month. Mr. Clarence B. Howard, of New York, and Miss Minnie Morey, daughter of Mr. and Mrs. Franklin Morey, of Denver, were married in that city on Thursday evening, February 22, in the Twenty-third Avenue Presbyterian Church. The Bride is said to be beautiful and accomplished, and interested in church and charitable work. The Groom is associated with the Safety Car-Heating and Lighting Company, of this city, and holds a responsible position and is well known to many of our readers. May he realize the truth of the saying of the wise man from the East, who wrote that "those who have wives are blest with good fortune. Wives are as friends who, by their kind and gentle speech, soothe you in your retirement. In your distresses they are as mothers, and they are refreshment to those who are travelers in the rugged paths of life."

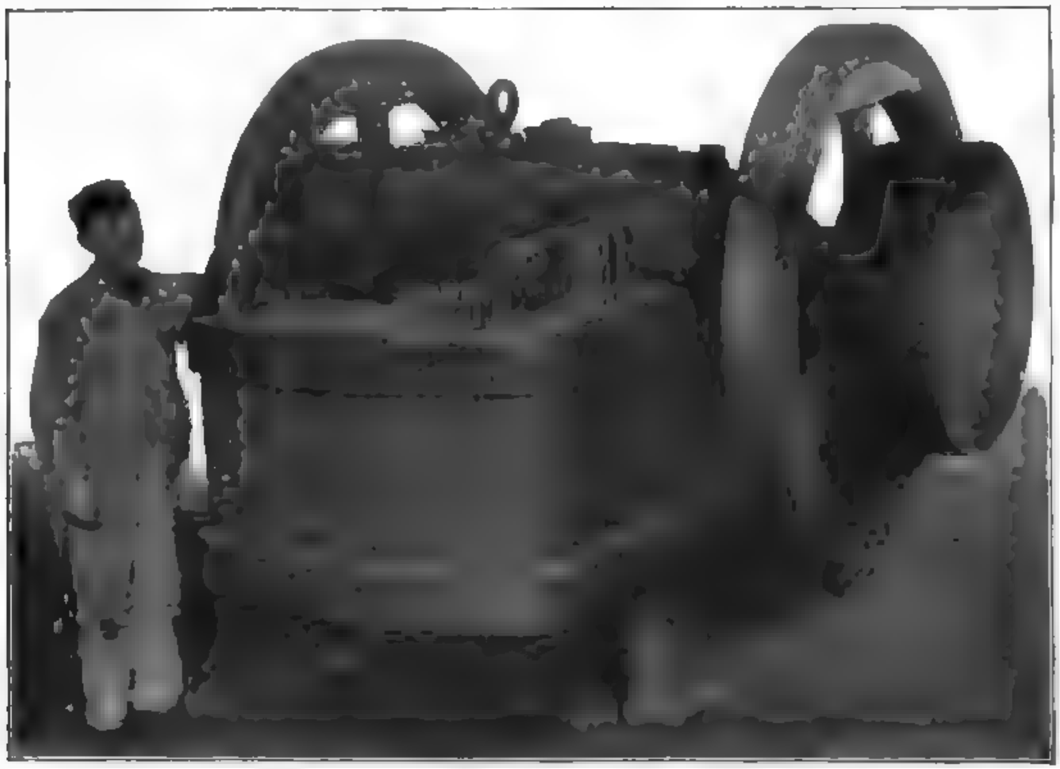
May felicity attend their steps.

Manufactures.

A NEW STONE-BREAKING MACHINE FOR ROAD-MAKING.

THE stone machine illustrated in our engraving is of special interest to contractors, engineers and others having to do with the breaking of stone for macadam and ballast. It was built especially for this class of work by the Farrel Foundry & Machine Company, Ansonia, Conn., and is one of a number of such machines recently furnished prominent contractors and for which there continues a general demand. While it does not depart in its general construction from the familiar design characteristic of the Blake style crusher, as long built by the Farrel Foundry & Machine Company, it does differ essentially in the distribution of weight and material used in its manufacture.

The Farrel crusher, as usually built, consists briefly of a strong iron frame, near one end of which is a powerful movable jaw of iron. By means of a toggle joint and eccentric this jaw is moved back and forward a slight distance from the frame. As the jaw recedes the opening increases and the stone descends; as it approaches the frame the stone is crushed. By an adjustable toggle-block the length of the stroke of the jaw can be adjusted to the size of any stone or particular product, and this while the machine is in motion. The needs of contractors for the class of work indicated demands a machine that is unusually strong and substantial, and so arranged that the wearing parts are easy of access and readily renewed. It was to meet just such requirements that the crusher presented was built, and the results have proved very satisfactory.



NEW STONE-BREAKING MACHINE FOR ROAD-MAKING.

In this machine the pitman and swing-jaw are of steel, which enables the Company to build them lighter and at the same time much stronger than would be possible were they constructed of cast iron. The swing-jaw shafts and eccentric shafts are larger than usual, the jaw-plates are of the best quality of charcoal iron, and the cheeks and other wearing parts are, with the exception of the plates, of steel.

The machine is simple and positive in its working. This machine is made in sizes as follows—namely, 15 in. × 9 in., 20 × 10 in., and 30 in. × 13 in. It is of interest to add that over 100 medals have been awarded crushers made by the Farrel Foundry & Machine Company at various expositions.

PETROLEUM IN JAVA AND SUMATRA.

WE have received from Mr. William Warren a communication anent the Sumatra and Java petroleum wells, in which he states that the average output there is 228 barrels per well per day, as compared with 241 barrels in Russia, and (up to the end of October, 1893) 59 barrels per month in the United States, while in Burma a well giving 25 barrels daily is considered a big well. The amount of the exports east of Suez exceeds 20,000,000 cases of oil per annum—a matter of paramount importance to Sumatra, as *good* oil cannot be obtained elsewhere in the East.

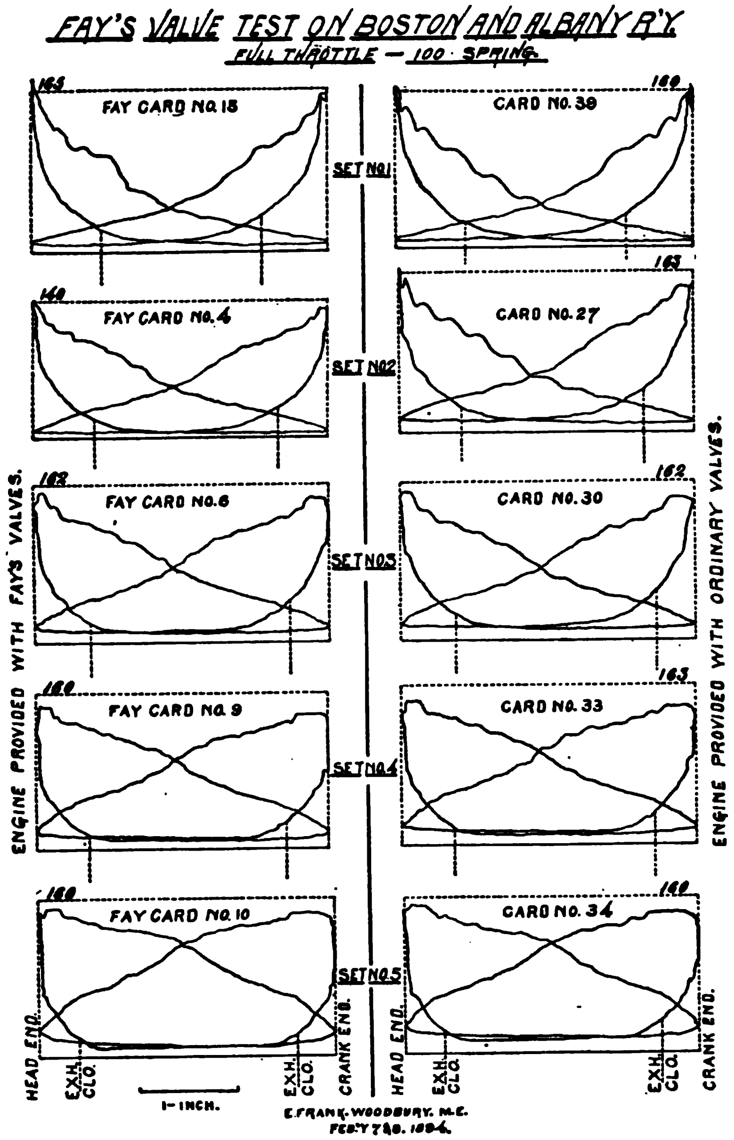
The Dordtsche Petroleum Company of Java commenced operations with a capital of 350,000 fr. (£29,250), and, it is stated, have since that date paid dividends aggregating 80 per cent. of the paid-up capital as above. At Wonokrona, 5½ miles from Soerabaya, a large oil refinery has been established which gives employment to about 2,000 men. The crude petroleum, which is obtained from a number of oil wells—about 27—which have been drilled to depths varying from 100 to 800 ft., in the village of Djabakotta, situated about 4 miles from Wonokrona, is conveyed to the refinery through a pipe line, although the oil is thick or heavy—namely, 28° to 42° Beaume, the warm climate keeping it fluid.

In another village (Gogoa) are other oil wells, the deepest of which is that 1,850 ft. deep, producing gas, the pressure of which is 488 lbs. per square inch, which is used as fuel for boilers and other purposes.

The Dordtsche-Java Petroleum Company, already mentioned, is said to possess drilling rights in Java over 150,000 bouws (262,800 acres, or, say, 410 square miles) of oil lands there, its present monthly output of refined oil being 45,000 cases, which it is expected will be doubled in a very short

time. Other petroleum concessions have been taken up and are being worked in Java, as at Gunong Sarie, the rights of which have been secured by a Chinese family, Tuan Lok, who are working it with a capital of 300,000 fr. (£25,000), the entire interests of which, however, are now said to be taken over by a large Chinese company with a capital of 4,000,000 fr. (£333,330). The area of the concession held by this company is given as 250 bouws (438 acres, or, say, seven-tenths of a square mile). The depth of their wells varies from 75 to 350 ft.; one of the shallowest, only 75 ft. deep, gives 396,000 liters (or, say, 11,000 cases) of oil daily, the density of which, as crude, is 17° Beaume, the wells being drilled at a cost of 2 fr. (say, 1*s.* 8*d.*) per foot for the first 150 ft. of depth. This Company, which is in active operation, has so far produced only an inferior product, for want of suitable new plant, some of which has now been ordered from Germany, of a monthly capacity of 1,000,000 liters; or, say, 1,000 cases daily. Some 12 wells are about to be drilled at several other places in this oil-bearing district, for which concessions have been granted and syndicates formed, as at Pasoeroen, Kedir, Toeban, and Rembang in Banjoewangie, Madura Island, etc.

The chief merit of the Java crude petroleum consists in the great value, both of the fair proportion of kerosenes, but especially of the unusually large proportion of valuable by-products as lubricating oils and paraffins, differing very considerably from the Langkat petroleums obtained in the neighboring island of Sumatra, these latter yielding about double the proportion of kerosenes and correspondingly less paraffins. The Royal Netherlands India Petroleum Company of Sumatra is at present producing about 1,600 cases of refined oil daily from three wells only—the promise of a large oil field in Langkat being, apparently, such as to make it more than ever regrettable, from a British point of view, that Lord Castlereagh should have bungled these rich islands out of the hands of the British into the hands of the more fortunate and successful Dutch.—*Commerce.*



FAY'S ENGINE VALVE.

Mr. Henry R. Fay, of 8 Exchange Place, Boston, Mass., has recently brought out a modification of the ordinary D slide-valve that serves to reduce the compression in locomotive cylinders. Its chief value is to be found when the engine is running at high speeds and the compression is excessive. It can be applied to any engine by drilling holes at the end of the bridge, at such an angle from the valve-seat to the bore of the cylinder that the piston packing will reach the first of the holes when a groove cut in the face of the valve, and extending across from one hole to the mate at the opposite end opens into the admission port after cutting off. In the applications that have thus far been made, these holes have been ⅜ in. in diameter, sufficient stock being left between the hole and exhaust to cover the groove in the valve. Each of the grooves in the valve is provided with two end cavities in the side of the valve, which are cut so as to reach the extra cylinder ports when exhaust takes place on the opposite end. A communication is thereby opened with the other end of the cylinder, allowing the compression to pass around the piston to the other end of the cylinder and exhaust.

The valves have been placed on a number of engines on the Boston & Albany Railroad, and a test was recently made with one of them for the purpose of determining the difference in back pressure between engines using the Fay valve and those with the ordinary valve. The general dimensions of the engine were:

Diameter of cylinder.........	18 in.
Stroke of piston....	22 in.
Diameter of driving-wheels...	68½ in.
Total weight of engine.......	90,800 lbs.
Steam-ports	14½ in. × 1 in.
Exhaust-ports................	14½ in. × 2½ in.
Valve travel.................	4½ in.
Outside lap..................	⅞ in.
Inside lap...................	0 in.
Working pressure.............	160 lbs.

On February 7 the test was with the Fay valve, the mean temperature 34° F., and the wind southwest, blowing from 15 to 20 miles per hour. The rails were frosty and the train consisted of one baggage-car, one smoking-car, two passenger coaches, and two 12-wheeled drawing-room coaches. Weight of engine and tender loaded, 80 tons. Estimated weight of train, 248 tons.

On February 8, with a temperature of 41° F. and the same wind, the ordinary valve was tried. The rails were wet (rain during the night of the 7th), and the train consisted of one baggage-car, one smoking-car, two passenger coaches, and two eight-wheeled drawing-room coaches. Estimated weight of train, 250 tons.

The train each day was the regular New York express (schedule train No. 63), leaving Boston at 9 A.M.; due at Springfield at 11.50 A.M.

The indicator was applied to the left-hand cylinder only, using a Crosby three-way cock with ½ in. pipe connections. During the tests every effort was made to permit the taking of duplicate indicator cards. All engine data (speed, boiler pressure, and cut-off) was taken to Mr. T. Purvis, Jr., Division Master Mechanic of the Boston & Albany Railroad, and as a result of his efforts and of the skill of the engineer of engine No. 173, the sets of diagrams shown in the table were produced under nearly the same conditions.

During the night of the 7th the steam-chest cover of the left-hand cylinder was removed and the four extra cylinder ports, each ⅜ in. in diameter, were screw-plugged, thereby making the left-hand cylinder the same as it was before the application of the Fay valve. In each test the same valve was used, without change, on the left-hand cylinder.

It is claimed that a comparison of the indicator cards given in the accompanying engraving shows the counter pressure to have been increased 29.2 per cent., or the average compression, including preadmission, was increased 24.2 per cent.,

and the average back pressure increased 38 per cent. with the ordinary valve over the Fay valve, this taking the atmospheric line as a base.

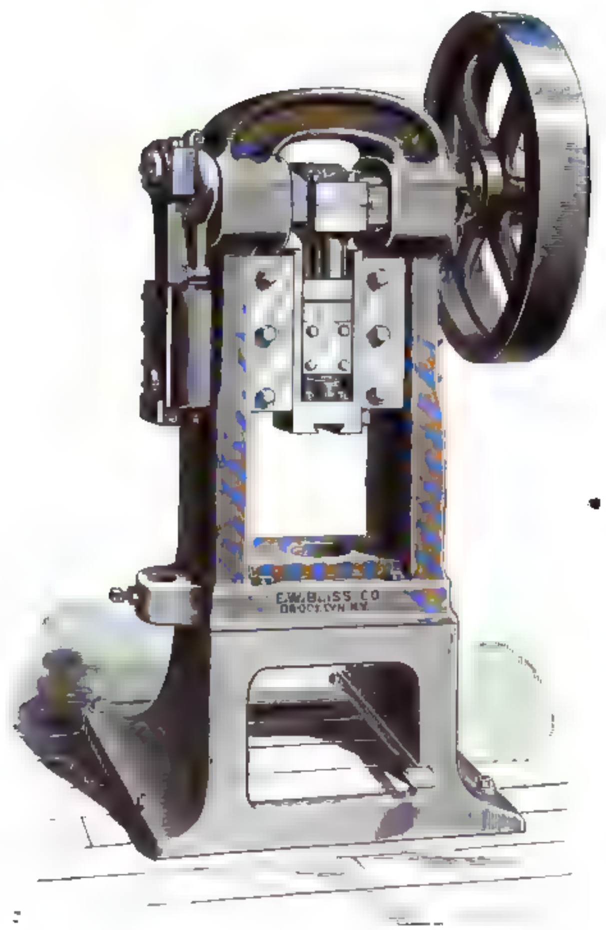
TRIMMING PRESS FOR DROP FORGINGS.

This cut represents a press of late design brought out by the E. W. Bliss Company, and it is intended for use in the forge shop where hot metal is to be trimmed. It was the intention of the designers to build a press that would meet as nearly as possible all the requirements for which a press of this class of work can be used. The press is fitted with the well-known Bliss clutch and a patented adjustment in the slide, and has a supplementary slide in the side of its frame to be used in cutting off the work from the bar after it is forged and trimmed. This is considered a new feature in a press of this kind, and will be at once appreciated by persons using such machines. The construction of the machine is very strong, and every detail has been carefully studied. These presses are built in several sizes and are usually made with fly-wheels, as forgings are usually required to be trimmed very quickly and a high-speed machine becomes necessary. This cut represents a press which has a 4-in. stroke, 4-in. adjustment, and is 15 in. from bed to end of slide when up; distance between uprights is 22 in. This machine carries a 908-lb. fly-wheel, the total weight being 5,500 lbs. The dimensions can be modified to suit special requirements if it is necessary. These presses can also be geared for cold trimming.

A SOLID ROCK DREDGER.

The great increase in size and draft of steamships of late years has rendered it necessary to deepen and otherwise enlarge the channels leading to many of the great harbors and docks of the world. In a number of instances the much-needed work has been delayed because, the entrance-way being formed through rock, the enlargement has had to be effected by the slow and costly process of first loosening the rock by blasting and afterward dredging up the spoil, the difficulties being greatly increased when the entrance was situated in an open sea-way. The tendency of recent practice has, therefore, been to construct the dredger of such strength and power as to enable it to cut its way through the solid rock without the preliminary operation of blasting. The latest instance of this method of procedure is afforded by the new channel leading to the harbor of Alexandria, which had to be excavated for a width of 300 ft. through a series of ridges of solid rock extending for about a mile in an open sea-way. The prevalence of a heavy swell greatly added to the difficulties of the work, which, however, was accomplished practically without the use of explosives, and constitutes a unique example of rock-dredging. The work was executed by Messrs. S. Pearson & Son, of Westminster, who afterward disposed of the dredger to the Government. Having, however, taken a contract for excavating a channel through the rock at Bermuda for the Colonial Government, the firm have had a new and very powerful steam dredger designed, which embodies various improvements suggested by their experience at Alexandria and elsewhere.

This is an 800-ton hopper dredger, and is being built and engined by Messrs. Lobnitz & Co., of Renfrew, at whose works we recently inspected the vessel. She is 208 ft. long over all, with a breadth of 40 ft., a depth of 17 ft. 3 in., and a displacement when loaded of 2,200 tons. She is entirely steel built, and will be capable of steaming to any part of the world at a speed of 7 knots. She will be propelled by twin screws, driven by independent triple-expansion engines of 800 H.P. The dredging-gear, ladder, and bucket chain are probably the strongest ever made, they are of steel and weigh together about 100 tons. The bucket chain will be driven by an independent compound surface-condensing engine of special construction with 16-in. and 30-in. cylinders respectively and a 2-ft. stroke, and working at 100 lbs. pressure. Steam for the engines will be provided by two cylindrical steel boilers of the return tubular type of 1,000 H.P. combined. They are arranged independently, so that one can be cleaned out while the other is in use for dredging. For ordinary service the vessel will carry 100 tons of coal, while for long voyages she can take in 600 tons. All the dredging-gear will have such an excess of strength that it will pull up the engine if any impediment is met with in working, and a breakdown will thus be avoided. The bucket ladder is fitted with 10 powerful buffer springs, which will cushion any shocks that may be experienced when the dredger is working in a sea-swell. By an



TRIMMING PRESS FOR DROP FORGINGS.

interchange of wheels dredging can be affected at three different speeds, to suit the degree of hardness of the materials met with. The vessel will dredge to a depth of 45 ft. below water level, and she will be able to cut "her own flotation"—that is, she will cut her way through a bank above water level. The dredged material will be delivered by the buckets through shoots into steel hoppers on either side of the vessel, each of which is capable of containing 7,000 cub. ft. of spoil, or it may be delivered into barges alongside, by altering the shoots. The vessel will also carry a special rock cutter for use in cases where the rock may prove exceptionally hard. She is likewise arranged for dredging in soft ground, and when cutting a channel such as a canal she will deliver the dredged materials on to the shore on either side.

The dredger is fitted with steam-steering gear, which can be worked from both of her bridges. A titan steam crane will be mounted on deck for moving any of the heavy parts for examination or repair, and there will be a set of artificers' shops, so that all ordinary and even heavy repairs can be executed on board. The vessel will be lighted throughout by electricity, and will carry a search-light. Ample accommodation is provided for the officers and crew, and, in addition to the usual boat equipment, she will carry a large steam launch as a tender. This dredger, which is the strongest and most powerful ever constructed, is being built to Lloyd's and the Board of Trade requirements as a sea going vessel, and will be launched about the beginning of February.—*London Times.*

AMERICAN ENGINEER AND RAILROAD JOURNAL.

Formerly the RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

The American Railroad Journal, founded in 1832, was consolidated with Van Nostrand's Engineering Magazine, 1887, forming the Railroad and Engineering Journal, the name of which was changed to the American Engineer and Railroad Journal, January, 1893.

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NEW YORK, MAY, 1894.

EDITORIAL NOTES.

THE Brazilian rebellion is at an end; and there seems to be no reasonable doubt but that the great and formidable *Aquidaban* has succumbed to the attack of a torpedo boat that came out of the fight unharmed. The vessel was all right as long as shots came through the air, and she passed to and fro before the forts in Rio Janeiro harbor with impunity; but the under-water attacks were too much for her, and down she went. This is what we all thought and figured upon, and little has been learned; but how about the efficiency of the *Nictheroy?* We must once more re-echo our regret that she could not have had a finger in the pie and at least fired one shot just to show whether the dynamite gun was a real weapon or a scarecrow.

THE question, "What are we coming to?" may well be asked regarding the criticisms now being heaped upon the navies of the world. Commencing with the nautical opera of "H. M. S. Pinafore," we have had one long series of ridicule and adverse scientific criticism of the British Navy, culminating in the "Cruise of the Mary Rose" and the topical songs of the London music halls. Then comes the latest shock of all in the scathing criticisms of the committee of the French Chamber of Deputies on the navy of France, of which the English critics have spoken so highly. At home we have received a rap on the knuckles in the examination of the *Machias* and *Castine*, but are assured that everything else is all right. Let us hope that it is.

THE discussion by the members of the American Society of Mechanical Engineers, published in another column, purports to bring out the fact that we really know very little about the behavior of materials below the elastic limit within the range of those strains which are employed in machinery and structures, as evidenced by the high factor of safety or "factor of ignorance," as one speaker put it. Would it not be just as proper to say that we do not know the strains to which a machine doing a given piece of work is subjected, and therefore cannot calculate the strength required of the material? Who, for example, can calculate the strains on the various parts of a steam excavator working in any soil? or who figures closely on the stresses applied to the various parts of a locomotive running at high speed over a crooked track? Twelve to one should give a fair margin of safety; but even with this we do occasionally hear of rods and frames breaking. Taking our ignorance of the behavior of metals and then squaring it by our ignorance of the stresses we are applying to it, we certainly do have a pretty heap of ignorance to compare with what we really know.

WATER-TUBE BOILERS.

THERE is probably no subject of more general interest to mechanical engineers, and about which there is such a diversity of opinion, as there is about the merits and demerits of water-tube boilers. At the recent meeting of the British Institution of Naval Architects a number of elaborate papers and much discussion was devoted to water-tube boilers, and revealed, what was known before, that persons with opportunities for getting information with reference thereto held very diverse and contradictory opinions. At this meeting, in one of the papers—by Mr. Howden—the author went on to record the various failures of water-tube boilers at sea—much more numerous than is generally known—and then proceeded to dwell on the merits of the cylindrical boiler." This form of boiler, the author said, "has been used for thirty years of uniform, unrivalled and continuing success, for every usable or practicable steam pressure yet required in sea-going steamers, and is still rising in efficiency, and was introduced on account of the failure of the water-tube, sectional and all other forms and types of boilers to supply sea-going steamers with high-pressure steam safely, easily and economically."

The writer of that paper then went on to compare the power, weight and space occupied by Belleville water-tube boilers in the steamers *Polynésian* and *Armand Behic* with the same function and features of cylindrical boilers capable of working continuously at the highest power attained by the Belleville boilers. These latter, we are told, on trial attained 8,000 indicated H.P., while their average working power at sea was 5,000 indicated H.P. They occupied 980 sq. ft. of floor space in the ship, and weighed, including water and all mountings and funnel, 380 tons. These particulars were then compared with those of cylindrical boilers capable of working continuously at the highest power attained by the Belleville boilers on trial—that is, 8,000 indicated H.P.—and also of working with ease and economy at the sea power of 5,000 indicated H.P., but which can be worked as high as 6,000 indicated H.P. when required. They occupied 877.5 sq. ft. of floor space, or 102.5 sq. ft. less than the Belleville boilers. The weight of the cylindrical boilers, including the fans and engines and all forced draft apparatus, water, funnel, and all mountings, as in the water-tube installation, was 361 tons, or 19 tons less than the Belleville boilers. The author of the paper pointed out that the quantity of water in the latter would probably not be more than one-third of that in the cylindrical boiler. He then criticised the feed-water arrangements and said: "These twenty water-tube boilers would require for continuous work at sea 20 men constantly engaged in regulating the feed supply; and even then the feed-water and steam pressure, and consequently the revolutions of the engines, would fluctuate greatly—a most objectionable result. The two cylindrical boilers, on the contrary, would only require the occasional attention of the engineer of the watch in the charge

of the machinery generally or his assistant. The large quantity of water acts as a storage of power, like the fly-wheel of an engine, and prevents rapid fluctuations, and gives ample time to call into action the reserve-feed pumps, or take other necessary precautions should any accident happen to the ordinary supply."

On the other side of the question, Mr. Thorneycroft, of torpedo-boat fame, read a paper in which he compared the water-tube boilers of his construction, which have been put into the third-class cruiser *Geiser*, with locomotive boilers which were put into the sister ship *Hecla*. "In the case of the *Geiser*," he says, "an equal power was given to that obtained in the sister ship *Hecla* with locomotive boilers, *but with a reduction of some sixty tons*." He then went on to call attention to what his firm undertook to do in the case of the *Speedy*. In this vessel they had guaranteed to give 1,000 more H.P. than with the locomotive boilers in sister vessels, "*and with a considerable less weight of boilers*." A tabular statement is then given from which the following data are taken: Indicated H.P. of locomotive boilers, 3,500; weight of boilers and mountings, dry, 82 tons; weight of water in boilers, 30 tons: total, 112 tons. Indicated H.P. of Thorneycroft water-tube boilers, 4,500; weight of boilers and mountings, dry, 79.74 tons; weight of water in boilers, 12.78 tons; total, 92.52 tons. The total weight per H.P. of the locomotive boilers is thus 71.6 lbs. and of the water-tube boilers, 46 lbs. The quantity of water in the boilers was, however, only 6.36 lbs. in the Thorneycroft boilers and 19.2 lbs. in the others. It is, therefore, perhaps not remarkable that, as Mr. Thorneycroft says, there was some difficulty encountered in feeding these boilers with sufficient regularity. Continuing, he said that "the system of feeding which was employed, and which was perfectly efficient for boilers holding large volumes of water, seems to require some modifications in the case of water-tube boilers, where the water contained is relatively very small for the rate of evaporation; and he had come to the conclusion that some form of automatic control is desirable." He also admitted that small quantities of grease in the boiler had disastrous effects. This admission of Mr. Thorneycroft would seem to be in a measure confirmatory of the charges of Mr. Howden; but to add to the doubt which any one seeking information on this subject must feel with reference to the whole subject, another speaker, Mr. Saxton, of Messrs. Maudslay, who took part in the succeeding discussion, commenting on that portion of Mr. Howden's paper in which it was asserted that 20 boilers would require 20 water tenders, said: "He had some experience in the French mail steamer *Normandie*, fitted with Belleville boilers. In the *Normandie* one man did the work of Mr. Howden's 20, and he was an Arab. As a matter of fact, the boilers had an automatic feed, which took care of itself; but if it did not, it made very little difference to the boilers. The last thing the engineers in the ship thought about was the water level. Many of the boilers in the ship had no glasses in the gauge fittings. In testing a Russian ship with a Belleville boiler, the gauge glasses broke early in the day; he wanted them replaced at once; but the engineer in charge only laughed, and a highly successful trial was made without them."

Mr. Yarrow also read a paper on this subject, in which he said that "In H. M. S. *Havock* they adopted two locomotive boilers, and indicated on trial about 3,500 H.P. with an air pressure of 3 in. In the *Hornet*, which is a sister ship, provided with similar engines and fitted with eight water tube boilers, as previously described, they obtained with a very low air pressure, averaging 1¼ in., 4,300 H.P. The eight boilers in the *Hornet* weighed 11 tons less than the locomotive boilers in the *Havock*. They had every reason to fear, from what they were told, that trouble would be experienced in working this group of small, rapidly evaporating boilers in the *Hornet*; but, as a matter of fact, they had experienced no difficulty whatever, the feed being arranged in, as it were, two stages. The feed pumps on the engines take their suction from the hot well, and deliver into a reservoir at 50 lbs. pressure, and from this the donkeys take their suction, each boiler being provided with an independent pump."

The discussion at the meeting, from the proceedings* of which we have quoted so liberally, indicates very distinctly that the water-tube boiler has come to stay. It has had a struggle for existence during its infancy, and the evolutionary process of the survival of the fittest is not yet ended; but the young leviathan is now too vigorous and is capable of doing so much good work that there is no probability that its kind will ever become extinct.

The makers and inventors of water-tube boilers apparently do not realize at its true value the importance of having a large volume of water relatively to the working capacity of the boiler. This has been demonstrated a thousand times in locomotive practice. As every one knows, the first locomotives were small, insignificant machines of a few tons' weight. Their size has been constantly increased until now we have the magnificent structures which weigh many tons instead of a few. During this process of growth the little machines have been constantly obliged to do more work than they were designed for, and their boilers have had to be forced to their utmost capacity. Now it has been a very common experience that boilers with a small water capacity always work unsatisfactorily when forced to do their utmost. As Mr. Howden pointed out, "the large quantity of water acts as a storage of power, like the fly-wheel of an engine, and prevents rapid fluctuations."

Some experience twenty-five years ago illustrated this. As all the participants in that experience are now dead excepting the writer, there is no impropriety in mentioning names. The Grant Locomotive Works, then located at Paterson, N. J., built some American type of locomotives for the Chicago, Burlington & Quincy Railroad, which had what are called straight-top boilers with barrels whose dimensions are now forgotten, but which were comparatively small. These engines were sent to Illinois and put on the road, and the Superintendent of Motive Power reported that they would not do the work they were intended for. The writer was sent out to investigate, and, if need be, subject them to a test. Mr. C. F. Jauriet was then at the head of the Machinery Department of that road. He referred to some engines which he had built and altered, and which, he said, were doing more work than those from the Grant Works. It was finally agreed to make a test of the two classes of engines. This was done on freight trains between Chicago and Aurora, Ill., with the result that the Grant engines were badly beaten. The facts were, though, that the Jauriet engines had boilers of considerably larger diameter and had a high "wagon-top" over the fire-box, which was widened out, thus giving considerably more water capacity both in the barrel and around the fire-box. As Jauriet expressed it, this enabled him to "bottle up the power." In the Grant engines great care had to be taken in carrying water, otherwise the boiler would "work water," whereas the other boiler could be pumped up so as to nearly fill the barrel, the wagon-top giving ample steam space. The engineers of these engines were not slow to avail themselves of this advantage, and on approaching the grades, which abound between Chicago and Aurora, would fill the boiler as full as they could, fire up and get it hot, and at the critical point, with a heavy train, if there was danger of losing steam, would shut off the feed and work over the hard place with their "bottled-up" reserve power, whereas the Grant engine had no such reserve to fall back on if the boiler did not make enough steam.

It is true that a marine boiler does not work under condi-

* Our quotations are from the columns of *The Engineer*.

tions which vary within such wide limits as a locomotive boiler must, but the disturbing influence of the rolling and pitching of a ship is greater than the motion of a locomotive, and "bottled-up" power is always a good thing to have at sea and on a railroad and elsewhere.

If at the discussion at the Mechanical Engineers meeting on the 9th the data could be submitted, from which a comparison would be possible, of the water capacity of different classes of locomotive, cylindrical and water-tube boilers relatively to their H.P., it would be both interesting and instructive.

NEW PUBLICATIONS.

PECK'S EXPORT PURCHASE INDEX. The first number of this publication, dated April 1, has been received. It contains 126 pp. 9¼ × 13 in., printed on coated paper with excellent typography and good taste. Its scope is stated to be that of a "trade exponent, covering the entire field of United States exports." It is proposed to give: 1. A list of manufacturers whose goods are indorsed as satisfactory to foreign trade. 2. An educational department, written by resident agents and commercial travelers in foreign countries. 3. Illustrations and descriptions of materials used in construction, with extracts from manufacturers' catalogues. These de-departments will be supplemented by the "confidential discounts" of the publishers, which will be "followed up with active and energetic solicitation on the part of the publishers, resident agents and foreign salesmen."

The publication is apparently intended to be the "organ" of Messrs. William E. Peck & Co., exporters, of New York.

SURVEYING AND SURVEYING INSTRUMENTS. By G. A. T. Middleton. Macmillan & Co., London and New York. 116 pp., 5 × 7½ in.

This book was evidently not written with any knowledge of the methods of surveying that obtain in this country. Indeed, it does not appear that the author has had any particular practical surveying experience, for, on examination of his titles displayed on the title-page, he introduces himself as a member of two associations of architects and as the author of two books relating to building. There is very little contained in this volume that is of any value to an American surveyor; the methods of making surveys are crude and obsolete, and some of its directions positively bad practice—as, for instance, its condemnation of longer offsets than one chain's length for fear of inaccurately forming a right angle from the base line, and even deprecating the use of any instruments for the more correctly erecting a long offset. The preference given to the making of a land survey by a series of triangles, each side of which should be measured with a Gunter chain of 66 ft., and the use of no instrument for the measurement of angles is bad teaching; but when the author explains his preference for the Gunter chain of 66 ft. with 100 links of 7.92 in. each, over the 100-ft. chain with 100 links, because each 66-ft. length is an eightieth of a mile, and because the 100-ft. chain "is heavy to drag," he becomes amusing. It would not be surprising if the American 100-ft. steel chain is found to be lighter than the bulky English larger guage iron wire 66-ft. Gunter chain.

A very valuable bit of information to young surveyors is that given on page 2 as the "best way" to range a line in over poles—namely, "to stand against one of the extreme poles, so that the nose is flattened against it, while one eye sees past each side of it, by which means that pole is lost sight of and the distant one only seen." Can it be that to this practice we may attribute the large proportion of red noses found ornamenting English surveyors of long experience?

With all the rudimentary instructions as to the conduct of a survey, down to the recommendation to unstrap the chain before throwing it out, the author gives no directions for leveling up or "breaking" a chain in measuring up or down sloping ground. Possibly the author did not know of the necessity of this if accuracy is desired. Two young men were found recently who had received C.E. degrees from one of the leading New York colleges, who deliberately chain up a 30° slope without "breaking chain."

Among the instruments described in the volume but few are in common use in the United States. Altogether, we do not find that this book covers any field that is not already very much better covered by a number of books treating the same subjects by other authors. It is really saddening to a lover of books to see good paper and ink thrown away recklessly in this way. It might be suggested to the author, "Schuster, bleib bei deinem Leisten."

TRADE CATALOGUES.

ANTI-FRICTION, OR BABBITT METAL. National Lead Company, No. 1 Broadway, New York. 8 pp., 8¼ × 6 in. This is a very small treatise on anti-friction metal, and is designed to show the superiority of the Babbitt Metal manufactured by this company.

HAND-POWER TRAVELING CRANES. Meavis & Beekley, Philadelphia. 8 pp. 5¾ × 8 in. This is a modest little pamphlet describing the traveling cranes manufactured by this firm. It contains an engraving representing one of their crane structures, a description thereof, and tables of the sizes manufactured, which range from two to ten tons capacity, and spans up to 36 ft.

THE CHARTER GAS-ENGINE COMPANY, Sterling, Ill. Last month we criticised a catalogue issued by this company, and suggested that a fuller description of their engines would add to the interest and usefulness of the publication. Since then we have received another edition of it which contains a good engraving of the engine, with explanatory references printed in it in red ink, which, with the description, make the construction quite clear. It is still thought, though, that with the aid of a sectional representation of the engine, and letters of reference, an explanation could be given which the wayfaring man and editors of papers could understand easier than they can a description without such illustrations.

MACHINE TOOLS FOR THE RAPID PRODUCTION OF LATHE WORK. The Lodge & Shipley Machine Tool Co. Cincinnati, O. 48 pp. 3¼ × 5½ in.

In the preface to this little pamphlet the publishers say very truly that "much thought has been expended on the rapid production of all work manufactured by the screw machine." It is then announced that they manufacture such machinery, and their catalogue is devoted to a description thereof. It is illustrated with small engravings of a 30-in. double-saddle turret lathe, a 60-in. pulley lathe, a pulley drilling and tapping machine, a 37-in. turret lathe, a 22-in. turret chucking lathe, a Fox monitor, a plain or back grand turret lathe, a horizontal and cylinder-boring machine (bores 18 in. in diameter × 8 ft. 6 in. long), a triple-facing machine, and a universal brass worker. Good descriptions of each of these machines are appended to the engravings. This publication is very convenient for carrying in the pocket; but the engravings are most too small to do justice to the machines they represent. Evidently this company has been giving much study to the production of machine tools to do work economically.

THE CHASE-KIRCHNER AERODROMIC SYSTEM OF TRANSPORTATION.

We have received a very well-printed pamphlet, describing what is called the "Coming Railroad." Briefly described, it is a somewhat remarkable elevated railroad, the vehicles of which are hung below the axles of the carrying wheels. These vehicles each have a system of aeroplanes on top, which are expected to sustain a part or the whole of the weight of the vehicles at high speeds. The scheme is not worthy of serious criticism. Lieutenant G. N. Chase, of the United States Army, and H. W. Kirchner, F.A.I.A.—whatever these letters may mean—are apparently the authors of the pamphlet and of the "Aerodromic System," which hails from St. Louis. When a machine, such as a steam-engine or type-writer, don't work right, we send it to a shop for repairs. There ought to be some analogous place to which inventors, whose heads don't work right, could have the logical faculty restored to them.

HEALD & SISCO CENTRIFUGAL PUMPING MACHINERY. Morris Machine Works, Baldwinsville, N. Y. 32 pp. 6¾ × 10½ in.

In the last number of the AMERICAN ENGINEER we noticed a descriptive circular and price-list issued by this company. Since then we have received from the same source a larger illustrated catalogue, which represents more fully the work done by these parties. The typography, engraving and printing of this are all excellent. There are wood engravings showing the Improved Double-suction Pumps, Vertical Pumps, Standard Horizontal Right-hand Pump (two engravings), Pump Wing and Pistons, Steam Pumps (two engravings), Standard Side-section Steam Pump, Improved Double-suction Steam Pump, Improved Hydraulic Dredging Pump, XL Ejector, Flap Valves, Foot Valves, Suction Hose, and Suction and Discharge Pipe. Besides these illustrations there are a number of diagrams made from drawings showing the posi-

tion, dimensions, etc., of the different classes of pumps. Tolerably full descriptions and tables accompany these engravings, and give an excellent idea of the kind of machinery manufactured by this company.

THE WESTINGHOUSE AUTOMATIC BRAKE CATALOGUE. Second Edition. 78 pp., 9 × 12 in.

This is a new edition of the former publication issued by the Westinghouse Air Brake Company, of Pittsburgh, to take the place of the 1890 issue, and illustrates the latest and most modern brake appliances as they have been practically developed. It is intended for the use of such railway employés as have occasion to order air-brake supplies, and will be sent to such persons on application.

Like all the publications issued by this company, it is magnificent in typography, engraving, and in its general conception. It would be difficult to find anywhere an engraving which is more comprehensive in the illustration of the organs and details, more lucid in the exposition of the functions of a complex mechanism, or more artistic in execution than the large folded plate showing all the parts of the brake apparatus. It is printed throughout on heavy coated paper, which brings out all the effect of the engraving, but it is to be feared will not stand the wear and tear of folding. All the other engravings are excellent, and have been drawn with reference to the purpose of the book, which is to facilitate the ordering of parts of the brake apparatus. Some new designs are to be found in the book—as, for example, the new 9½-in. improved air pump, on page 6. Some diagrams are also given which are intended as guides to persons ordering driving-wheel brakes for locomotives. The volume ends with the "Conditions under which Air Brake and Train Signaling Apparatus is Sold."

FULL INFORMATION FOR THE ERECTION AND USE OF THE BAKER CAR HEATERS. Revised Edition. By William C. Baker, 143 Liberty Street, New York. 42 pp. 4⅝ × 8 in.

The purpose of this book is expressed in its title. It is literally "*full*" information. It may be said of Mr. Baker, or the author of the "Information," whoever he is, as Herbert Spencer said of Tyndall: "He is an excellent expositor;" and this, Spencer goes on to say, "implies much constructive imagination." All that we have room to say here is that the directions given are very full, very clear, and easily understood. Explicitness is carried to the extent of giving engravings—and very good ones, too—one of a piece of "the largest size coal to be used in the heaters," and another showing a piece of the "smallest size."

Interspersed through the book are a number of apothegms—usually printed in italics—which it is a public benefit to impress on the minds of railroad men. The following are examples: "*Pure air is as essential to the comfort of the passengers as is warm air. There is no need of consuming more coal than is required. You cannot adapt the weather to the fire. Never go away*" (it should have been added, *nor go to sleep*) "*and leave the draft full on the fire. Never let the fire go out. Never take the water from the heater nor the heater from the car. Have it always ready for service.*" The following final injunction, it is hoped, will be generally observed: "*Simply obey all the rules, and mind all the advice given in this little book.*" Mr. Baker should have added: "Fear God, and keep His commandments; for this is the whole duty of man."

THE NEW PATENT BILL.

Provisions to Protect Innocent Purchasers and Inventors.

THE bill amending the patent laws in various particulars recently agreed on by a sub-committee of the House committee on patents has been printed, and will probably be laid before the full committee at its next meeting. The measure contains provisions for the protection of innocent purchasers of patents and limits to one year the time within which applications for patents on articles already patented abroad must be made in this country. The section for the protection of innocent purchasers of patents provides that whenever a patent is alleged to be infringed, the patentee shall seek his remedy by bringing suit in the first instance against the manufacturer or vendor of the article alleged to infringe said patent, and that in no case shall an action be maintained against any individual who shall have purchased, in good faith, a patented article of a regular dealer in the open market for his own use, or who shall innocently use the same for agricultural or domestic purposes, until after such patent has been sustained by a decree of a court of competent jurisdiction, nor unless such purchaser shall fail or refuse to give to the patentee or his representative, at his request, the name and residence, if known to such purchaser, of the party from whom he purchased the patented article.

An important amendment carried by the bill reduces from two years to six months the time in which all applications for patents filed shall be completed and prepared for examination. Upon the failure of the applicant to prosecute the same within six months after any action thereon, they shall be regarded as abandoned by the parties thereto, unless the delay was unavoidable.

INTERNATIONAL STANDARDS FOR THE ANALYSIS OF IRON AND STEEL.

THE Sub-Committee on Methods for the Analysis of Iron and Steel have sent the following bulletin to the iron and steel chemists of the country, so far as they could get their names. They earnestly request that any who do not receive a copy of the circular, but who do see this, will comply with the request of the bulletin the same as though they had received a circular direct.

CIRCULAR TO IRON AND STEEL CHEMISTS ON METHOD OF DETERMINING PHOSPHORUS.

DEAR SIR: At the World's Congress of Chemists in Chicago a Sub-Committee of the original Committee on International Standards for the Analysis of Iron and Steel was appointed to consider the subject of Standard Methods.

This Sub-Committee consists of Dr. C. B. Dudley, Chairman; Messrs. A. A. Blair, W. P. Barba, P. W. Shimer and T. M. Drown. It has recently held a meeting and has decided to recommend standard methods in iron and steel analysis to be used as the basis of commercial transactions. The Sub-Committee fully appreciates the fact that these methods, to have the highest value, should be in facility and in time of execution such that they will readily recommend themselves for daily use in iron and steel works.

To further this end the Sub-Committee wishes to have the co-operation of the iron and steel chemists of the country, and to ask them for a brief outline of the processes or methods they use and prefer for the determination of different elements in iron and steel, and for such other information and suggestions as they think will aid it in the work before it. The Sub-Committee recognizes the fact that it will add immensely to its efficiency and value if the iron and steel analysts of the country will take a personal interest in it, and aid it by their counsel and active influence.

You are therefore requested to send to the Chairman of the Sub-Committee, as soon as convenient, such an outline as you may deem sufficient to fully describe your practice. It is suggested that you follow the general plan here indicated, by answering the following questions, which may be referred to by number to save you unnecessary trouble.

1. What general method do you use for the determination of phosphorus in iron and steel?
2. What special precautions do you consider necessary to make this method reliable?
3. What precautions do you take to prevent the interference of arsenic?
4. What factors do you use in your calculations?
5. What variations do you introduce in the case of iron ores or slags?
6. Do you use the same method in pig iron and steel and do you consider the results equally reliable?
7. Do you ever examine the residues insoluble in acid, in pig irons, or iron ores and do you ever find phosphorus in them?
8. Are all your determinations made by the same method, or do you check your work by reference to another method, and if so, what method do you use for this purpose?
9. How many determinations do you make a day in your laboratory under ordinary circumstances?
10. What do you consider the greatest length of time necessary to obtain a result, permissible in your work?

The Sub-Committee begs that you will send at the earliest possible moment as full replies to all or any of the above questions as you conveniently can, and assures you that in making use of any details that may be original with you, you shall have full credit. You will likewise be furnished with copies of the various reports.

CHARLES B. DUDLEY,
Chairman Sub-Committee,
ALTOONA, PA.

APPROVED,
J. W. LANGLEY,
Chairman Com. on Int. Standards.

PERFORMANCE OF ENGINE 870 ON THE NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

THE following very remarkable performance of this engine will interest many master mechanics and locomotive engineers. Who can beat it?

ON EMPIRE STATE EXPRESS TRAIN, RUNNING NORTH; ON SOUTHWESTERN LIMITED TRAIN, RUNNING SOUTH.

Out of the shop	March 26th, 1893
In the shop	April 2d, 1894
Period out of the shop	370 days
Idle	10 "
Continuous service	360 days
Made 360 round trips between New York and Albany.	
Mileage during that period	105,866 miles
Cut out on April 5th, 1893, for broken follower bolt	10 minutes
Cut out February 6th, 1894, whistle broken	30 "
Total time lost by reason of engine failures	40 minutes
No other engine failures.	
Time lost other than engine failures	21 h. 57 m.
Made up exceeding schedule time	39 " 51 "
Total time made up exceeding schedule time and time lost	17 h. 14 m.

NOTES AND NEWS.

Liverpool Station in London.—The enlargement of the Liverpool Station in London is proceeding rapidly, and when completed, it is claimed that it will be the largest station in that country. It will have 18 platforms and 20 lines. At the narrowest part of the approach there will be 6 lines, and with the new signal arrangements and short blocks, it will be possible to run trains in or out every 2 minutes. At present between 700 and 800 trains are run in and out daily; but the enlargement will enable the company to operate 1,000 trains a day.

Railroad Through the Sea.—An interesting experiment is about to be carried out at Brighton, Eng. A marine railway will connect Brighton with the little village of Rottondon. The rails will be laid on solid rock with a car, and at high water will be covered with the sea, which, however, will not affect the carriages, as the latter are to be supported on framework raising them above the level of the water. At this part of the coast the cliffs are high and the beach inaccessible, so that no boating will be interfered with. The cars are to be moved by electricity.

Swiss Cable Railways.—The last of the Swiss mountain railroads is that up the Stanserhorn, which rises 6,235 ft. above sea level, a little south of Lake Lucerne, not very far from the Pilatus and the two Rigi railroads. It is a cable road, or, rather, three cable roads, each with two cars, a motor at the upper end, and an automatic turnout in the middle. The passengers change cars at the end of each line. It can carry 32 persons every 16 or 17 minutes, and, including the changes of passengers, the time required to reach the summit is 54 minutes. The fare for the round trip is $1.55. The first section is 1,585 m. long, and rises 276·7 m.; the second section, 1,082 m. long, rises 508.4 m., and the third, 1,270 m. long, rises 627.8 m. The grades of the first section vary from 422 ft. to 1,452 ft. per mile; of the second and third, from 2,112 ft. to 3,273 ft. per mile. A contemporary says the braking is effected from the motor stations, and is novel—peculiarly formed rails being required for it. The motive power is electricity, generated at each motor station by water power.—*Engineering.*

German Process of Drying Wood.—A German process for drying woods has been tried, and with some success, by a firm of Canadian lumbermen. It consists briefly in placing the timber for 12 days in chambers heated by steam and then in another room to dry. The plan, it is said, entirely gets rid of sap, and has been found more efficacious with juicy woods like beech and birch. It is certainly the case that timber prepared by this means is largely used in Germany, and particularly in Bavaria. At the same time it is stated that this artificial seasoning is not nearly so efficacious as that produced by natural means. Woods thus forced into maturity are apt later on both to warp and to rot. The constructors of the German navy have altogether declined to use wood so prepared, though it has been found useful for fencing and other kinds of cheap carpentry.—*Manchester Courier.*

Aerial Railway at Gibraltar.—A cable railway has recently been erected at the rock of Gibraltar, carrying a suspended car, in which all kinds of materials are transferred to the summit of the rock. The time required is about five minutes. At the north end of the Alameda is an engine house from which two cables rise with a stretch of 300 yds. as far as the edge of the cliff. Above this point the convex shape of the rock necessitated their being raised from the required height of the ground by means of trusses. The cables are constructed with a capacity of 70 tons, but the strain upon them is never allowed to exceed six.

Armor Plates in the British Navy.—The following is from a report emanating from official sources: The past year has been remarkable for the results obtained from experiments conducted with steel armor treated by the "Harvey" process. Armor plates supplied by four firms have been tested, by and for the Admiralty. The investigation has been most thorough and extensive, and, as a result, orders have been given for Harveyed steel armor for the *Renown*, *Majestic*, and *Magnificent.* In the course of the experiments the use of nickel as an alloy of steel for the purposes of armor-plates has been fully tested. It has been established that Harveyed plates without nickel in the steel show resistance to modern projectiles as great as any hitherto obtained when nickel was combined with steel in plates also treated by the Harvey process. The consequence of adopting this new system will be a great saving in cost for a given defense. By means of these improvements the power of defense obtainable with certain thicknesses and weights of armor has been very greatly increased, and this circumstance must considerably affect the designs of battleships to be laid down in the future.

German Locomotives.—Mr. G. Lentz, in a recent address before a German engineering society on locomotive design, said that the German and other continental locomotives are modeled after both English and American designs, with the result that a mixture of the features of both is found in them; the practice of later years, however, following rather more closely the lines of English builders. But the inside cylinders and crank-axles of the English engine have not found favor, at least not in Germany, where sharper curves are permitted than in England, and where, therefore, numerous crank-axle failures have led to the adoption of outside cylinders. Compared with the English locomotive, the American engine does not commend itself in appearance to Mr. Lentz's tastes; there being, as he puts it, less beauty of design in its make-up, while in many cases it is embellished with flourishes and needless ornamentation which give it an unrestful air. The English builder, on the other hand, aims at the utmost simplicity, and turns out an engine solid and clean cut in appearance. Next to the English engines in the order of merit, so far as appearance is concerned, Mr. Lentz places those of Belgian make, in which inside cylinders largely prevail. Crank-axle fractures, however, occur in large numbers with these, notwithstanding the fact that their design provides for an extra bearing for these axles.

Boilers and Machinery in the British Navy.—The following extracts from a report show the progress which is being made in the British Navy in the use of water-tube boilers: During the year 1893–94 a large number of ships have passed satisfactorily through their contract steam trials. They included eight battleships, six first-class cruisers, three second-class cruisers, eight torpedo gunboats, and the torpedo-boat destroyer *Havock.* The *Devastation* has been re-engined and fitted with boilers of the common combustion chamber type. The tubes being fitted with the Admiralty cap ferrules enabled the trials to be accomplished satisfactorily. The fitting of these ferrules has been extended in the boilers of her Majesty's ships with satisfactory results. In connection with the propelling apparatus of the *Powerful* and *Terrible* it became necessary to decide whether, in view of the very high sea-speed for which the vessels are designed, and the great power required for the attainment of that speed, a new departure should not be made, and boilers on the "water-tube" principle adopted. After full inquiry into the experience gained in recent years with water-tube boilers fitted in sea-going ships, it was decided to adopt a type which has proved successful on a large scale and over long voyages. These boilers will be made in this country, and the orders for the machinery have been placed with two of the most eminent private firms, whose competency for the task they have undertaken is undoubted. The *Speedy* is the first ship in the Navy fitted with a group of water-tube boilers. They are of the Thorneycroft type, and with engines

by Messrs. Thorneycroft & Co. She accomplished over 4,700 indicated H.P., the contract being 4,500. Water-tube boilers of English design and manufacture, have been or are being fitted in a number of torpedo-boat destroyers now in course of construction, and those that have been tested have given most promising results. The torpedo-boat destroyer *Hornet*, engined by Messrs. Yarrow & Co., is fitted with a set of the Yarrow patent water-tube boilers, and her preliminary trials have given very promising results, her speed having exceeded that of the sister vessel, the *Havock*, the first of her class which is fitted with locomotive boilers.

The object of this paper is to represent graphically the action of one or more driving-wheels during an entire revolution, at different speeds and under different conditions in a series of diagrams, arranged to show at a glance the vertical influence of the extra counterweight used to overcome the action of the reciprocating parts, and the effect of these parts to equalize the pressure on the crank-pin.

It is not claimed that any new facts will be offered, nor that the matter here presented will particularly interest those who have made a comprehensive study of the subject, but is rather designed to show it in a pictorial way, somewhat in the man-

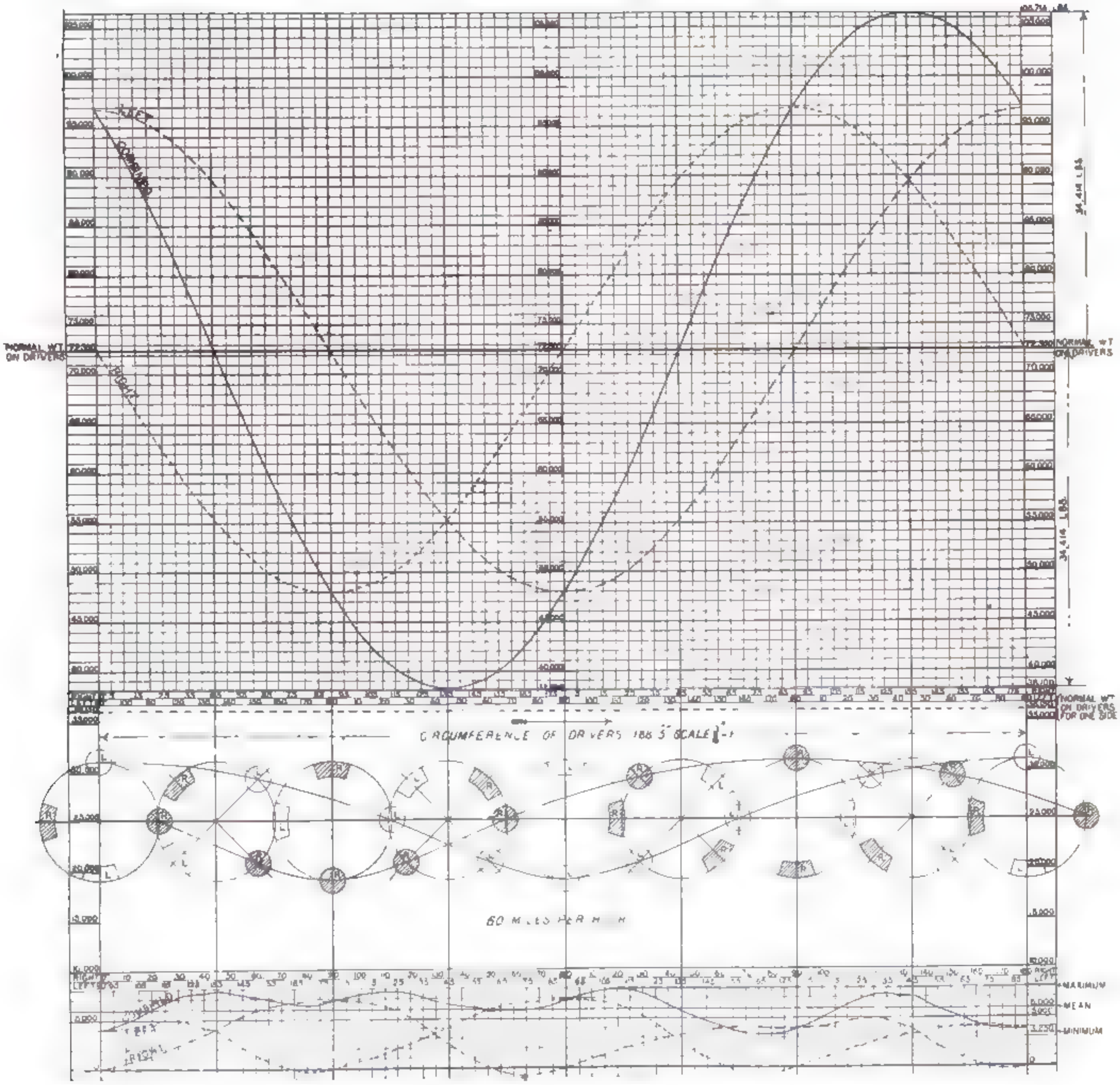


Fig. 1.

ner a sketch or drawing would illustrate some object one had in mind.

The effect on the track of a rapidly revolving, unbalanced wheel to increase or diminish the static weight borne by the drivers of locomotives can be readily calculated by means of the usual formulæ for centrifugal force. At the risk of seeming to repeat and reproduce here much that can be found in works on the steam-engine and physics, it is thought best to make a full explanation of the subject.

The word centrifugal is derived from Latin, *centum*, a center; and *fugere*, to flee; and is defined as "that force by which a body moving in a curve tends to fly off from the axis of motion in a tangent to the periphery of the curve." It is

THE RECIPROCATING PARTS OF A LOCOMOTIVE.

By F. J. Cole, Mechanical Engineer, Baltimore & Ohio Railroad.

There has lately been a marked revival of interest in the counterbalancing of locomotive driving-wheels, caused largely by the higher speeds now in vogue, the increased weight of the reciprocating parts (especially in compound engines), due to the large cylinders required for the powerful locomotives at present employed in the economical operation of railroads, and the recent laboratory tests made at the Purdue University.

best understood in the simplest form as the tendency to break a string, to one end of which a weight is tied revolving around in a circle. It equals in pounds one-thirty-second part of the weight of the rotating mass multiplied by the square of the velocity in feet per second, with which the center of gravity of the weight moves in its path, and divided by the radius, in feet, of the circle of motion of the center of gravity of the weight.

Or, expressed in revolutions per minute, the formula becomes the well-known and familiar one usually used in the calculations of governors, fly wheels, and other parts and details of steam-engines :

$$\text{Cent. } F = W \times R^2 \times r \times .00034,$$

in which

W = weight in pounds ;
R = revolutions per minute ;
r = radius in feet.

The revolutions per minute corresponding to different speeds in miles per hour, for various diameters of driving-wheels, are giving in the following table :

Diameter of Wheel.	Miles Per Hour.						
	40.	50.	60.	70.	80.	90.	100.
Inches.	Revolutions per Minute.	Revolutions per Minute.	Revolutions perMin.	Revolutions perMin.	Revolutions perMin.	Revolutions perMin.	Revolutions perMin.
44	305.58	....	......	......	.. ...	......	......
50	268.92	336 15	......	......	......	.....	......
56	240.12	300.15	360.18	.. ...	......	......	......
60	224.10	280.12	336.15	392.17	.....	......	......
62	216.87	271.08	325.30	379.52	433.74	......	......
68	197.73	247.16	296.59	346.03	395.46	444.89	... ..
72	186.75	233.43	280.12	326.80	373.48	420.17	466.86
78	172.39	215.48	258.58	301.68	344.78	387.87	430.97
84	160.07	200.09	240.10	280.12	320.14	360.15	400.17
90	149.40	186.75	224.10	261.45	298.80	336.15	373.50
96	140.06	175.07	210.09	245.10	280.12	315.13	350.15

Counterweights are added to all locomotive driving-wheels to balance the total revolving weights, consisting of the crank-pin, crank-pin boss, side or parallel rod, and back end of main rod, and a portion or all of the reciprocating weights, consisting of the piston and rod, cross-head, and front end of main rod. To obtain a perfect horizontal balance, all the weight of the reciprocating parts must be balanced in the counterweight, as it is evident upon a little reflection that the centrifugal force of the weight will exactly equal and neutralize the effect of the other when they are similar.

The vertical disturbance, however, is increased in direct proportion to the extra amount added over and above the weight required to balance the revolving parts.

In view of this fact, the practice of railroads and locomotive builders generally is to vary the amount from two-thirds to the full weight, according to the style of engine, speed, and other considerations.

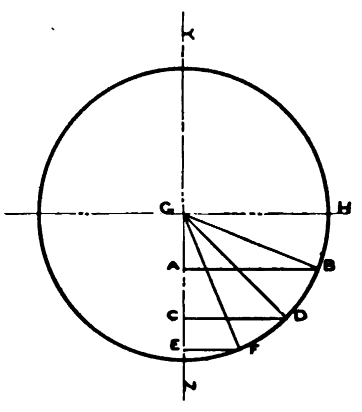


Fig. 2.

The smoothest running engines at high speeds are those fully balanced. This has been demonstrated so repeatedly on engines with varying amounts, that it now seems pretty well understood ; but on account of the excessive vertical effect on the track, caused by rapidly revolving, unbalanced wheels, it is considered by many that the minimum amount consistent with comparative freedom from excessive fore-and-aft jerking should be used.

The varying increase and decrease of the normal weight on the drivers can be quickly comprehended by means of curves plotted for given weight, speeds, etc. Fig. 1 shows the effect of reciprocating parts of an eight-wheeled engine having four coupled drivers and a four-wheeled truck.

Diameter of drivers.................	60 in.
Size of cylinders.......	18 in. × 24 in.
Weight on drivers.......	72,300 lbs.
Steam pressure............	160 lbs.

Weight of reciprocating parts :

Piston and rod............................	285 lbs.
Cross-head................................	138 "
One-half main rod....	211 "
Total.....	634 lbs.

On the diagram the spaces between the horizontal lines represent 1,000 lbs., and each vertical line 5° of crank movement, 72 lines in all equaling 360°, or one revolution. The heavy horizontal line marked, "Normal weight on drivers," is the weight—72,300 lbs.—carried on them, plotted from the base-line.

In this diagram the weights borne by each wheel have not been considered, as the effect of each side of the engine and the combined or total effect of all drivers has been plotted. While the individual result is slightly different when plotted separately, yet the total result of one side or of both sides or all the wheels is the same. Later on the exact effect of each wheel will be considered. The speed of the engine is assumed to be 60 miles per hour. As the drivers are 60 in. in diameter, the number of revolutions per minute will be 336. The maximum increase or decrease of the normal weight on the drivers for one side will be $W \times R^2 \times r \times .00034 = 634 \times 336^2 \times 1 \times .00034 = 24,335$ lbs. Referring to the relative positions of cranks and counterweights shown toward the bottom of the diagram (on the line marked 25,000, merely for convenience, because of the blank space in the diagram), commencing on the extreme left, the counterweight for the left side is shown down at its lowest and the crank at its highest position at 90°, both marked L. Consequently, as the unbalanced weight tends to fly out radially from the center, the normal weight—36,150 lbs.—or load borne on the drivers when the engine is at rest will be increased by the amount of the centrifugal force—24,335 lbs.—making a total of 60,485 lbs.

The base-line for one side is the heavy, dotted, horizontal line marked 36,150. The vertical height from it to the curved lines marked right or left will be the weight on track for either side at any position of the crank.

The dotted, curved line at upper left-hand corner of diagram marked left is plotted by making the height equal 60,485 from its dotted base-line or 60,485 + 36,150 = 96,635, from the real base-line corresponding to the marginal figures. Following out the motion of crank, from left to right, the succeeding positions for each 45° can be found by multiplying the maximum centrifugal force by the *sine* of the angle, thus : 24,335 × 7,071 = 17,207 lbs. + 36,150 = 53,357 lbs., or if desired, the same result can be obtained by multiplying by the vertical ordinates A, B, C, D, E, F, on the line Y, Z, fig. 2, and dividing by the radius ; 53,357 is measured from the dotted base-line, or 53,357 + 36,150 from the real base, and the position plotted on vertical line marked 135° for left crank angle.

At 180° the counterbalance exerts no vertical force, as the tendency is entirely horizontal, and is absorbed or neutralized by the reciprocating parts when they are equal in weight. This position for the curve on diagram is at 36,150 from the dotted base for one side, or 72,300 from the real base-line, consequently it is located at the intersection of the vertical line for 180° left crank angle and the heavy horizontal line marked in margin 72,300 lbs. Continuing the curve, the normal weights of engine at rest gradually diminishes as the counterbalance passes the horizontal line and approaches the upper portion of wheel. The centrifugal is exerted upward, and must be deducted from the weight on the drivers, becoming a minus quantity, precisely as it was plus during the first quarter of a revolution, followed on the diagram until the minimum is reached at the position of the crank angle marked left 90°, after the wheel has completed half a revolution. The intermediate positions for each 5° can be found in like manner, and the location plotted on the diagram, making the curved line as shown.

The curve for right side is started at 36,150 lbs.—the normal weight—90° ahead at the left, and is plotted out in exactly the same way. The two curves, then, for right and left

side, shown in dotted lines, represent the independent effect of the driving-wheels coupled together for each side. Owing to the cranks being set at 90° apart, and the counterbalances located exactly opposite thereto, it follows that when one weight is exerting its maximum effect up or down, the opposite side will be zero. The wavelike increase or decrease of weight can be readily followed on the diagram, the curved lines for each side being similar, but occupying position 90°, or one-quarter of a revolution apart horiontally, tending to resenting normal weight, and must be plotted above or below that line, as the combined effect of both curves, measured on any vertical line, becomes a minus or plus quantity.

Following this combined curve from the left to the right, it starts at 24,335 lbs. above the normal, falling to the normal at one-eighth of a revolution, because at this point the left is 17,207 plus and the right 17,207 minus; the combined effect is zero.

Advancing now to the next 45°, the curve is — 24,335 lbs.,

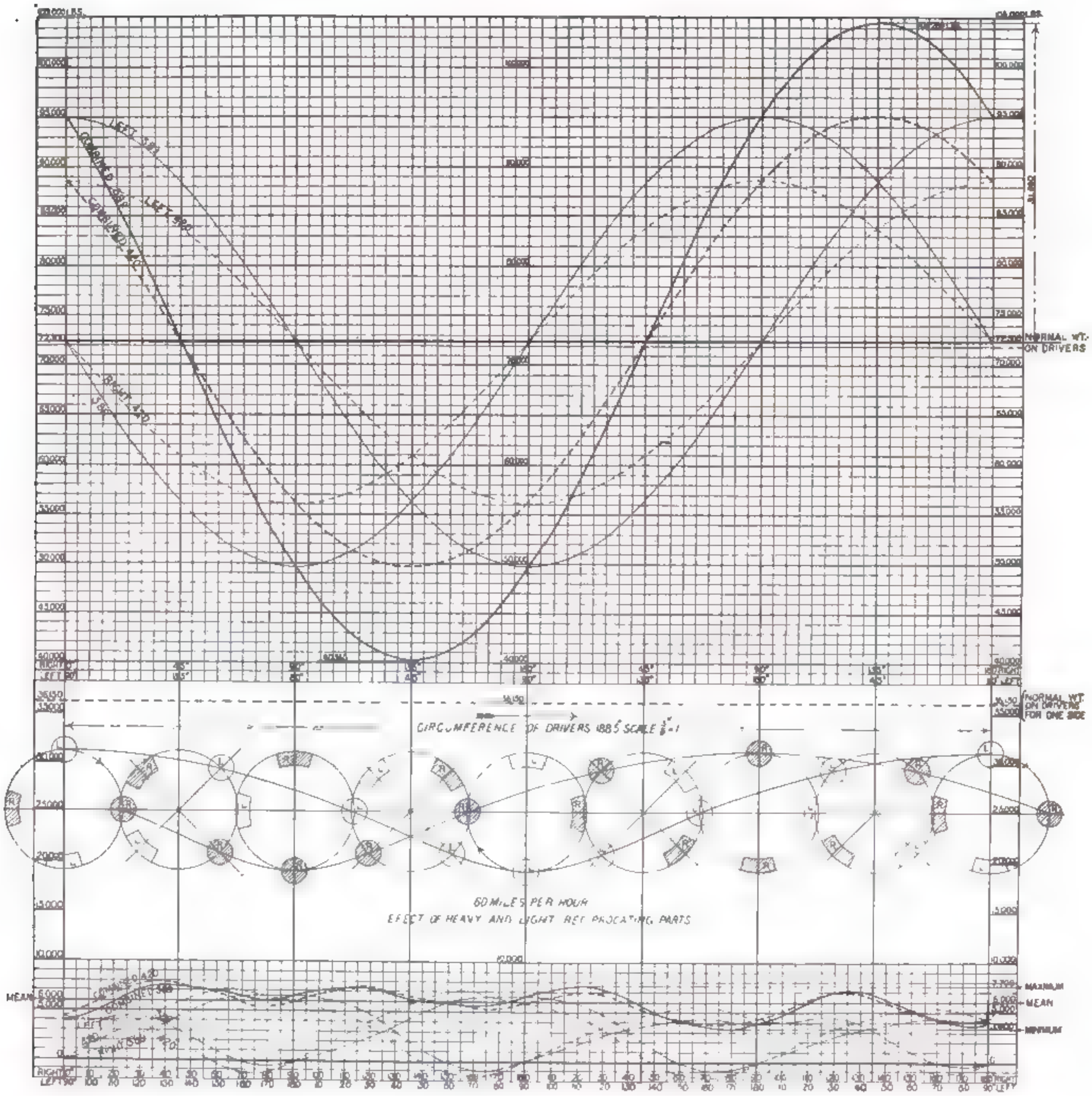


Fig. 3.

away the engine from side to side and swing it like an inverted pendulum.

Combining these curves, the line shown full and marked "combined" is formed. Commencing at the left of diagram, it is plotted out from the horizontal line marked 72,300 lbs. normal weight of drivers, and represents the total effect of all four drivers on the track, in a length and width of a space occupied by the driving wheel-base, similar to the floor of a track scale on which the drivers alone were being weighed.

It is formed by measuring on all the vertical lines the point of intersection of both curves for each side from the line rep- derived entirely from the right side, as the left at this position is zero.

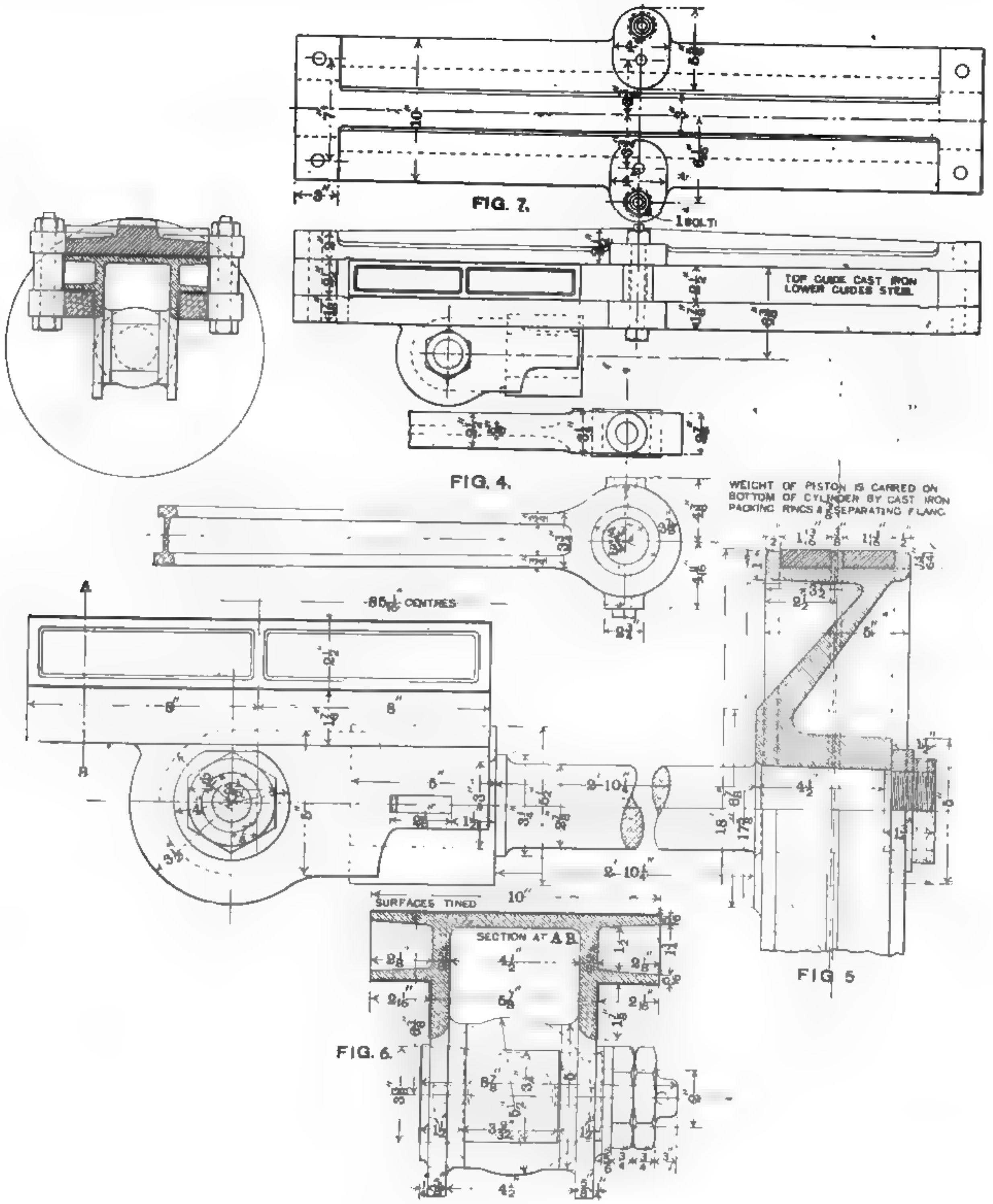
At the next 45° the maximum decrease of weight is reached, as the effect of both cranks is the same, being — 17,207 lbs.; the combined curves is — 17,207 × 2 = 34,414 lbs.; this subtracted from 72,300 lbs., the weight on drivers at rest, leaves 37,886 lbs. as the minimum weight. Combining the curves in a similar manner for the remaining one half revolution, it reaches the normal weight again at 90°, and the maximum in 180°; the weight is increased by a like amount—viz., 34,414 + 72,300 lbs. give 106,714 lbs. maximum.

From this combined curve the alternating increase and decrease of weight is easily followed by the eye, the diagram being figured and plotted to give it prominence.

It will be observed that the variation in weight during one-half revolution is 106,714 − 37,886 = 68,828 lbs., approaching and almost reaching the weight on the drivers when the engine is at rest.

On fig. 1, at the bottom, are shown curves representing the tractive force of the locomotive, corrected for the influence of the reciprocating parts during one revolution. These are best and most clearly shown in their relation to the weight on the drivers on the same diagram, and will be considered at length later on.

Fig. 3 represents a diagram constructed in the same manner as fig. 1, showing the effect of light and heavy reciprocating parts at 60 miles per hour. Class of engines, weights, etc., are same as considered in fig. 1, except the heavy reciprocating weights are taken at 589 lbs. instead of 634, the difference being that in the first case half the actual weight of the main rod is taken, and in this the actual weight of front end of the same, so that it would be in harmony and could be properly compared with the lighter design. The effect of the heavy parts is shown in full, curved lines, marked left 589, right 589, combined 589. Total increase of decrease of weights each side of engine, due to the heavy reciprocating parts, is 22,600 lbs. instead of 24,207, as in fig. 1. The combined effect of these curves to increase or decrease the total weight resting on the driving-wheels is 31,960 lbs., making the alternations



of weight during one-half revolution 63,920 lbs., and the actual weight on the drivers 40,340 minimum and 104,260 as maximum.

The heavy reciprocating parts (589 lbs., effect shown in full lines) are the actual weights of a class of engines that are rather lighter than the average construction. They are selected as representing good practice and average conditions at the present time. The light reciprocating parts (420 lbs., effect shown in dotted lines) are the estimated weights of re-designed parts combining lightness and ample strength for the purpose, which are reduced to the least possible weight considered practicable for every-day service. The curves for each side, representing the effect of the parts weighing 420 lbs., increase

rod, it is well known, will give satisfactory service if suitable material for bushing is used, and the wrist-pin, thoroughly hardened and ground perfectly true, and fitting neatly in bushing. The back end of the rod being merely balanced as the revolving weight is not shown. The cross-head is represented in fig. 6, made of cast steel, with an open, annular, diagonal web; the back and the cylinder-heads having corresponding projections fitting into its cavities to reduce its steam clearance spaces to a minimum. The weight of the piston is carried by the wide, cast-iron packing ring and the ⅜-in. center separating flange, so that the cast steel, except in this narrow center piece, does not come in contact with the bottom of the cylinder.

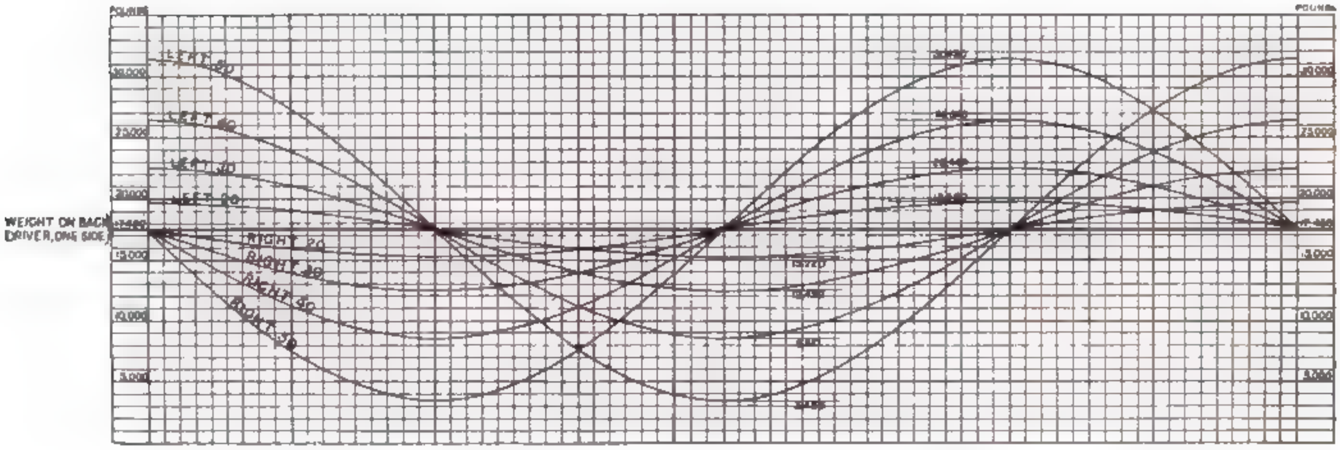


Fig. 8.

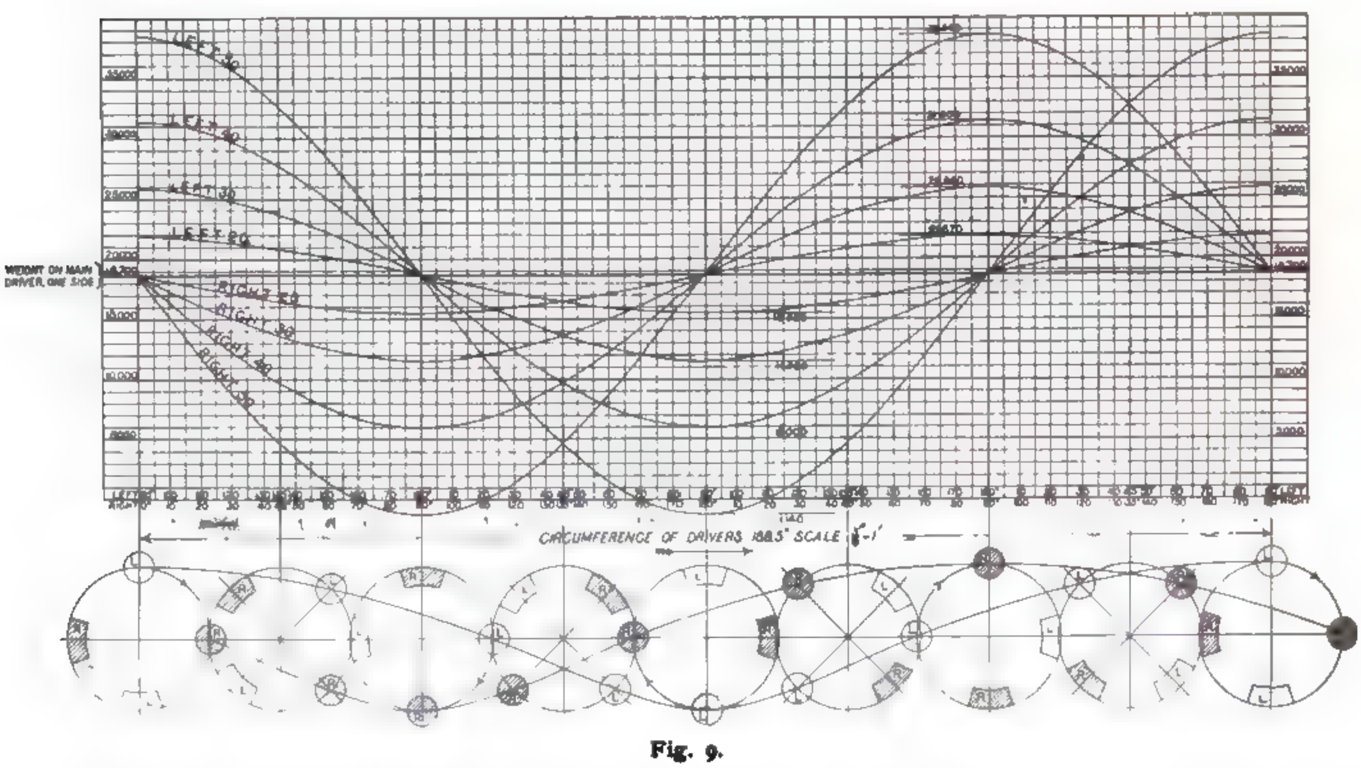


Fig. 9.

and decrease normal weights 16,120 lbs. The combined effect of these curves to increase or decrease the total weight is 23,796 lbs., making the alternations during half a revolution 45,592 lbs., and the actual weight on the drivers 49,504 minimum and 95,096 maximum.

These light parts have never been used collectively in service, but were designed by the writer as a practicable method of reducing the excessive weight without venturing into any doubtful or unusual construction.

Fig. 4 shows the front end of the main rod with a solid bushing. The rod is steel, milled out to an I section. This form of

Cast steel is usually considered a poor wearing metal, and its surfaces, when in sliding contact with other metals, are always protected by Babbitt tin, brass, or other metals having good wearing qualities. The piston-rod is of the usual construction, merely reduced in diameter, so as to allow ¼ in. or ⅜ in. wear and reduction in size before it is necessary to replace it.

It is not considered practicable to allow its diameter to be less than 2½ in. (when worn out) for the size of cylinder and steam pressure. The cross-head is of cast steel, shown in fig. 6, with tinned wearing surfaces.

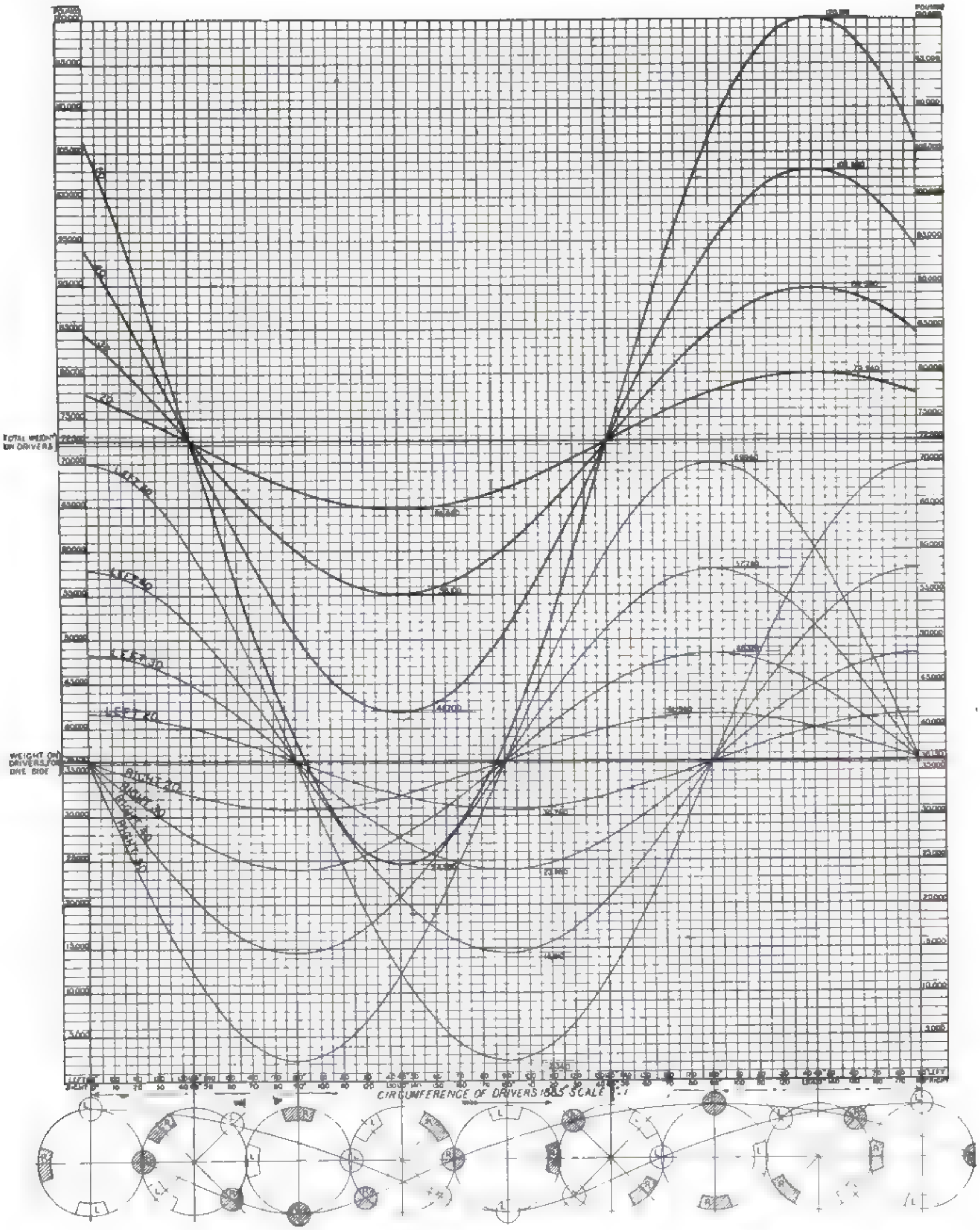

TOTAL WEIGHT ON DRIVERS
WEIGHT ON DRIVERS FOR ONE SIDE
LEFT 80
LEFT 50
LEFT 30
LEFT 20
RIGHT 20
RIGHT 30
RIGHT 50
RIGHT 80
CIRCUMFERENCE OF DRIVERS 180 SCALE 1:1

Fig. 10.

As nearly all engines, with the exception of those engaged wholly in switching service, run forward almost entirely, the upper wearing surfaces have been made unusually large, and the lower reduced to a minimum.

The guides are represented by fig. 7, and are made of cast iron. The upper one covers the full width of the cross-head, affording large bearing surfaces and efficient protection from dust and dirt. The lower guides are supported by a bolt and thimble, on account of their narrow width, to prevent springing when the engine is run backward.

The estimated weights are as follows :

Cast-steel cross-head with key and wrist-pin......	92.73 lbs.
Steel piston-rod and nut....................	90.36 "
Cast-steel piston-head and packing rings	129.20 "
Front half of main rod.......................	97.50 "
Total....................................	419.79 lbs.

The vertical effect of the counterbalances is very much intensified when a locomotive is hauled light with the main and side rods removed, being increased in the exact proportion of the amount of counterweight added to balance the main and side-rods, the effect of which must be added to increase or decrease the weights already found, for the vertical action of the counterweight placed to balance the reciprocating parts. Evidently in this case each wheel should be considered separately, as the main drivers have an excess of weight placed there to balance the back end of the main rod.

Fig. 8 shows the curves plotted for the same class of engines before considered. The back drivers for right and left side are shown separately. The speeds are 20, 30, 40, and 50 miles per hour, the latter being an excessive speed for freight trains, liable sometimes to be reached in exceptional cases, though scarcely ever exceeded.

The normal weight on this pair of wheels is 17,450 lbs.

Speed,	20 miles per hour;	min.,	15,220 lbs.;	max.,	19,680 lbs.
"	30 " " "	"	12,420 "	"	22,480 "
"	40 " " "	"	8,510 "	"	26,390 "
"	50 " " "	"	3,480 "	"	31,420 "

Fig. 9 shows the curves plotted for main drivers at the same speeds. Normal weight on drivers, 18,700 lbs.

Speed,	20 miles per hour;	min.,	15,530 lbs.;	max.,	21,870 lbs.
"	30 " " "	"	11,560 "	"	25,840 "
"	40 " " "	"	6,000 "	"	31,400 "
"	50 " " "	"	– 1,140 "	"	38,540 "

At 50 miles per hour the driver lifts from the track, the weight being a minus quantity of 1,140 lbs.; the curve being extended below the base-line, and the maximum weight 38,540 lbs.

Fig. 10 shows the curves of single, main, and back wheels combined for each side, as shown in the light full lines, and for the total combined effect of all four drivers, shown in the full heavy lines.

This diagram shows the lines for one side, and both sides in their true relation to the same base-line, and not from one horizontal line with two base-lines, as in figs. 1 and 8.

The diagram under consideration, made in this manner, shows it in a much more graphic and clear manner than when the eye is confused by more than one base-line ; the vertical distance showing at a glance the exact amount on the track at any point of the revolution. The normal weight on drivers for one side is 36,150 lbs.

Speed,	20 miles per hour;	min.,	30,740 lbs.;	max.,	41,560 lbs.
"	30 " " "	"	23,980 "	"	48,320 "
"	40 " " "	"	14,510 "	"	57,790 "
"	50 " " "	"	2,340 "	"	69,960 "

In the combined curves for all four drivers, the total normal weight on drivers = 72,300 lbs.

Speed,	20 miles per hour;	min.,	64,660 lbs.;	max.,	79,940 lbs.
"	30 " " "	"	55,100 "	"	89,500 "
"	40 " " "	"	41,700 "	"	102,900 "
"	50 " " "	"	24,500 "	"	120,100 "

In all these diagrams the full weight of the reciprocating parts has been balanced. While this cannot be claimed to be the universally accepted method of counterbalancing, it is by no means unusual or little used. Something less than the full weight of reciprocating parts can be used without injuring materially the smooth running of the engine. As the friction of the piston on the bottom of the cylinder and the packing surrounding the piston-rod have, no doubt, some slight influence in reducing the amount of weight required to accurately balance the horizontal motion of these parts, the practice at the present time would indicate that a very slight amount, ranging from 10 to not over 20 per cent. of the total weight, can be omitted without injurious jerking or fore-and-aft irregular movement. It therefore follows that the most promising line of improvement lies in a reduction of the weights of the reciprocating parts. It is not an extravagant statement to make, that by a little careful designing a very great reduction can be made in the weight, without impairing the efficiency, strength or durability of these parts. Much more attention has been paid in Europe to the reduction of weights of cross-heads and pistons than in this country. The tendency to the use of compound engines in the last few years has called attention to this matter in a more pronounced manner than would otherwise have occurred, owing to the enormously increased weight and size of cross-heads and pistons used in this class of engines.

The weight of reciprocating parts on a number of modern single-expansion engines is given below :

SIZE OF CYLINDERS.

	20 x 24.	21 x 26.	18 x 24.	19 x 24.	19 x 24.	18 x 24.	19 x 24.	19 x 24.	20 x 24.	19 x 24.	20 x 24.
½ main-rod....	217½	263	211	153½	152	170	166½	179½	206¾	200	234¼
Crosshead.....	240	261	138	190	201½	204	182	138	208	160	205
Piston and rod.	386	425	285	278	291	293	300	320	362	306	362
Total....	843½	949	634	621½	644½	667	648½	637½	776¾	666	801¼

(TO BE CONTINUED.)

BOILERS AND FEED-PUMPS OF THE UNITED STATES BATTLESHIP "TEXAS."

In continuation of our description of the machinery of the United States battleship *Texas*, we present in this number engravings illustrating the details of the construction of the boilers and feed-pumps. Both were built at the Richmond Locomotive Works, of Richmond, Va., the boilers from the specifications furnished by the department, and the latter from the designs of Mr. C. J. Mellen, chief draftsman for the contractors. The boiler is of what may be called the standard type for the double-ended boilers of all of the vessels of the United States Navy, and differs only in detail from those of the *Minneapolis* and other vessels heretofore illustrated in the pages of THE AMERICAN ENGINEER.

There are four boilers, each having a mean diameter of 14 ft. and a length of 18 ft., and with six corrugated furnaces with a minimum diameter of 3 ft. 3 in. and a length of 6 ft. $8\frac{7}{8}$ in. There are 168 stay-tubes and 642 ordinary tubes in each boiler, the length between tube sheets being 6 ft. 9 in. The external diameter of all the tubes is $2\frac{1}{4}$ in.; the ordinary tubes are No. 9 B. W. G. in thickness, and are swelled to an outside diameter of $2\frac{9}{16}$ in. at the front ends, the back ends being expanded into the tube sheet and beaded over. The stay-tubes are reinforced at each end and swelled at the front end to a diameter of $2\frac{3}{4}$ in. Of these tubes 144 are $\frac{5}{16}$ in. thick, and 24 are $\frac{3}{8}$ in. thick ; all of them being threaded at both ends to fit the threads in the tube sheets, into which they are screwed and then made tight by expanding and beading over. All tube spacing is fixed at the uniform distance of $3\frac{1}{4}$ in., both vertically and horizontally, and so disposed that there are 136 tubes for each of the side furnaces and 133 for each center furnace. This makes the efficiency of each furnace the same, and the products of combustion of each are kept separate and apart until they reach the uptake. For this each furnace has its own combustion chamber made of $\frac{17}{32}$ in. plates, except the tube sheets, which have a thickness of $\frac{3}{4}$ in.

The furnaces are of the well-known Fox corrugated pattern, made of one piece of steel $\frac{1}{2}$ in. thick. These furnaces, like all others in use on American vessels, were made by the Continental Iron Works, of Brooklyn, N. Y. The method of manufacturing these corrugated furnaces requires special skill and special machinery in order to do it successfully. The sheets are first bent in ordinary bending rolls, and then the longitudinal seam is welded by heating the overlapping edges of the plate with furnaces using water gas as fuel, after which the heated part is passed between bending rolls. But little hand work is done, as hydraulic rams and lifts are used for forming the weld and handling the sheet. After the welding is completed the shell is heated in a circular and vertical gas furnace burning producer gas, into which the shell is lowered by a hydraulic crane. Here the temperature is raised

to a bright cherry red, and then the shell is carried to the corrugating rolls, where in about five minutes the work of corrugating is completed. These rolls have the general appearance of vertical bending rolls, except that the rolls are corrugated instead of being smooth. Owing to the rule regarding the size of the corrugations in the furnaces of marine boilers, one set of rolls is sufficient to do the work on all sizes of furnaces and all thicknesses of sheets. The rule, as adopted by the Board of United States Supervising Inspectors of Steam Vessels, is that the corrugations shall have a pitch of 6 in. and be 1½ in. deep, and the formula used for the calculation of the thickness and steam pressure is

$$\frac{14,000}{D} \times T = \text{working pressure in pounds per square inch,}$$

in which

$14,000$ = a constant;
T = thickness in inches;
D = mean diameter in inches.

This naturally simplifies matters very much indeed, as there is no variation in the shape, but merely an increase in the thickness of the metal as the diameter or working pressure is increased.

810 tubes 2¼ in. external diameter by 6 ft. 11 in. long	3,587 sq. ft.
6 corrugated furnaces	268.9 " "
6 combustion chambers	372.2 " "
Total	4,228.1 sq. ft.
Total heating surface for four boilers	16,912.4 " "

The grate bars are of cast iron with side bars of cast steel made to fit the corrugations of the furnaces, and with wrought-iron bearers. The average dimensions of the grate bars are 3 ft. 5 in. × 6 ft. 6 in., which, for the six furnaces, gives an area of 132.9 sq. ft., and for the four boilers 531.6 sq. ft. Comparing this area with that of the heating surface, we find that the ratio between the two is as 1 to 31.8. The area through the tubes is to the grate surface as 1 to 5.9.

All plates, rivets, braces and stays are of open-hearth steel, the tubes also being of steel. Plates 1$\frac{3}{16}$ in. thick are used for the shell, which is built up of three courses, each course being composed of two plates. The heads are of three plates riveted, as shown in the half-end elevation of the engraving on page 204. The upper and middle plates are ¾ in. thick, while the lower one, which is flanged inwardly at the furnaces, is $\frac{11}{16}$ in. thick. The tube sheets are ¾ in. thick, great care having been taken to get each pair accurately parallel. All of the

CORRUGATED FLUES FOR BATTLESHIP "TEXAS," MADE BY THE CONTINENTAL IRON WORKS, BROOKLYN, N. Y.

In order to get one of the rolls through the shell, it is lifted out of the machine by a hydraulic lift and dropped back into place when the shell is in position. The machine is then started, being driven by its own engine. The corrugated roll, that was taken out in order to get the shell in place, turns in immovable bearings, while the other is crowded against it to produce the corrugations. It requires about five minutes to do this work. After the corrugations are completed any flanging that may be required for fastening to the boiler shell is done, after which it is annealed and tested for leakages. Flange steel having a tensile strength of not more than 65,000 lbs. per square inch of section is used for all corrugated furnaces.

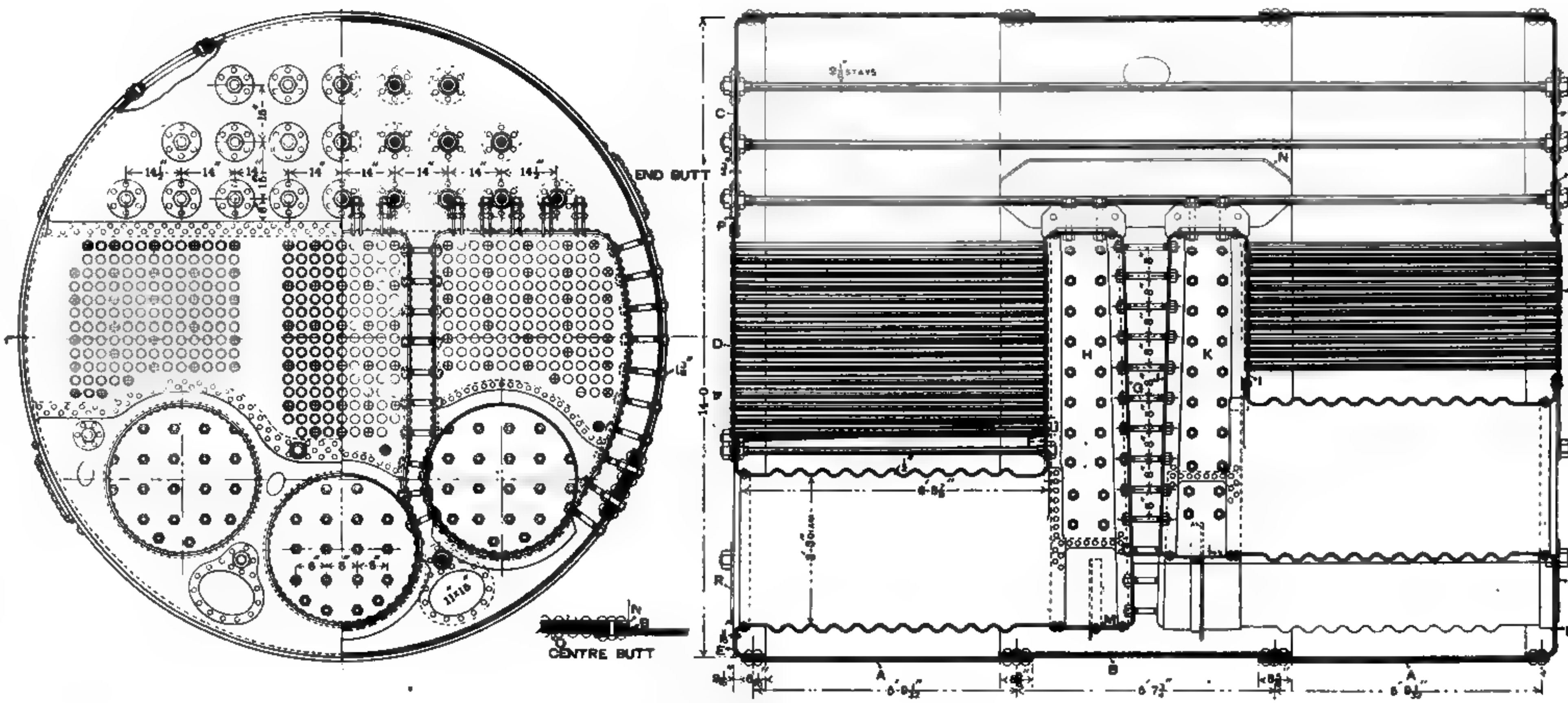
There are 24 of these furnaces in the boilers of the *Texas*, a photo-engraving of them being shown on page 205.

The heating surface in each of these furnaces is 44.81 sq. ft., making 268.9 sq. ft. for the six furnaces in a boiler. The heating surface of the whole boiler may be divided as follows:

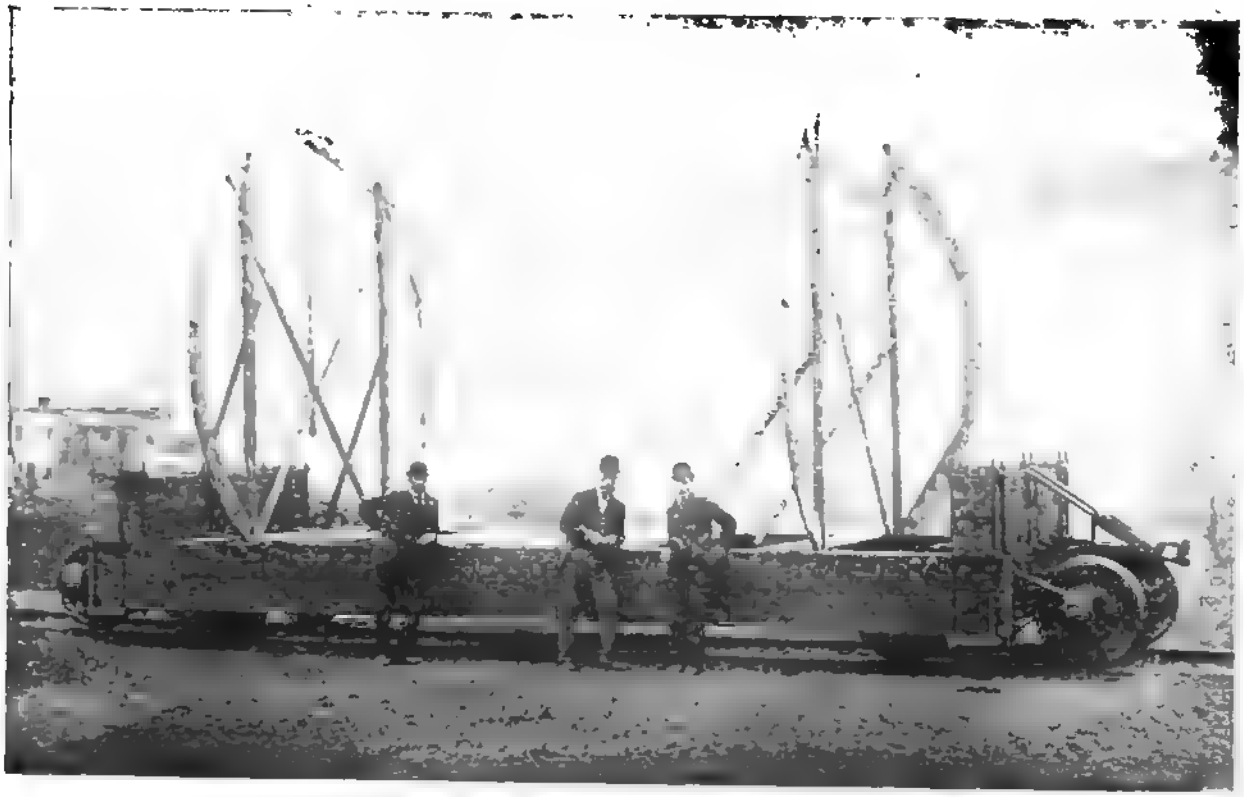
tube holes are slightly rounded at the edges, and the holes for the stay-tubes were tapped in place.

A reference to the engraving will show the method of staying above the tubes. There are twenty-one 2¼ in. through braces in three horizontal rows in each boiler. Each row is spaced 14 in. from center to center horizontally, except the outer ones in the bottom row, which are 14½ in., the vertical spacing being 15 in. The ends of the braces are expanded to 2¼ in. diameter, and are provided with nuts both inside and outside the boiler, the outer ones screwing up against washers ¾ in. thick riveted to the heads. The tube sheets are also stayed by three 1¾ in. braces in each that are swelled to 2¼ in., and screwed into them and further secured by one in the back tube sheet and two at the front, like the through braces already mentioned. Finally, there are two 2¼ in. through braces between the furnaces.

The staying of the combustion chambers is effected by staybolts 1¾ in. diameter spaced 8 in. apart, both horizontally and



BOILERS OF THE UNITED STATES BATTLESHIP "TEXAS," BUILT BY THE RICHMOND LOCOMOTIVE WORKS, RICHMOND, VA.



SPECIAL CAR FOR TRANSPORTING BOILERS OF THE UNITED STATES BATTLESHIP "TEXAS."

BOILERS OF THE UNITED STATES BATTLESHIP "TEXAS."

vertically. The tops are further stayed by bridge braces made of two steel plates $\frac{5}{16}$ in. thick, spaced 8 in. apart between centers The bottom of the combustion chamber is stiffened by angles, and all braces are weldless.

The longitudinal seams of the shell are butted with welts both inside and outside $\frac{11}{16}$ in. thick treble riveted. This leaves the plate with 82 per cent. of its original strength, while the rivets, which are $1\frac{1}{4}$ in. diameter, driven in holes $1\frac{5}{16}$ in. diameter, possess 86 per cent. of the same strength. The circumferential joints are lapped and double riveted, the furnace joints and combustion chambers single riveted. In order to avoid strains in the material, the specifications required that the shell plates should not be sheared nearer the finished edge than a distance equal to half the thickness of the plate along the circumferential seam, nor nearer than the thickness along the longitudinal seam, and all rivet holes in the shell were drilled in place after bending.

Each boiler has two 11-in. × 15-in. manholes in each head, and a 12-in. × 16 in. manhole in the shell near the top of the middle section, in addition to which there are four 6-in. × 4-in. hand-holes in each head.

The boilers are divided into four groups, each in a separate water-tight compartment, with athwart ship fire-rooms entered through suitable air-locks.

All of the external fittings of the boilers are of composition metal, and are flanged and through riveted or bolted. Each boiler has an internal brass dry-pipe $8\frac{1}{2}$ in. internal diameter and No. 14 B. W. G. thick. It is perforated on its upper side with longitudinal slits 3 in. long, $\frac{1}{4}$ in. wide, and $\frac{1}{2}$ in. between slits. There are two $4\frac{1}{2}$ in. spring safety-valves on each shell but in one case, and the springs of the same have such a length that the valves can lift one-eighth of their diameter at 150 lbs. pressure.

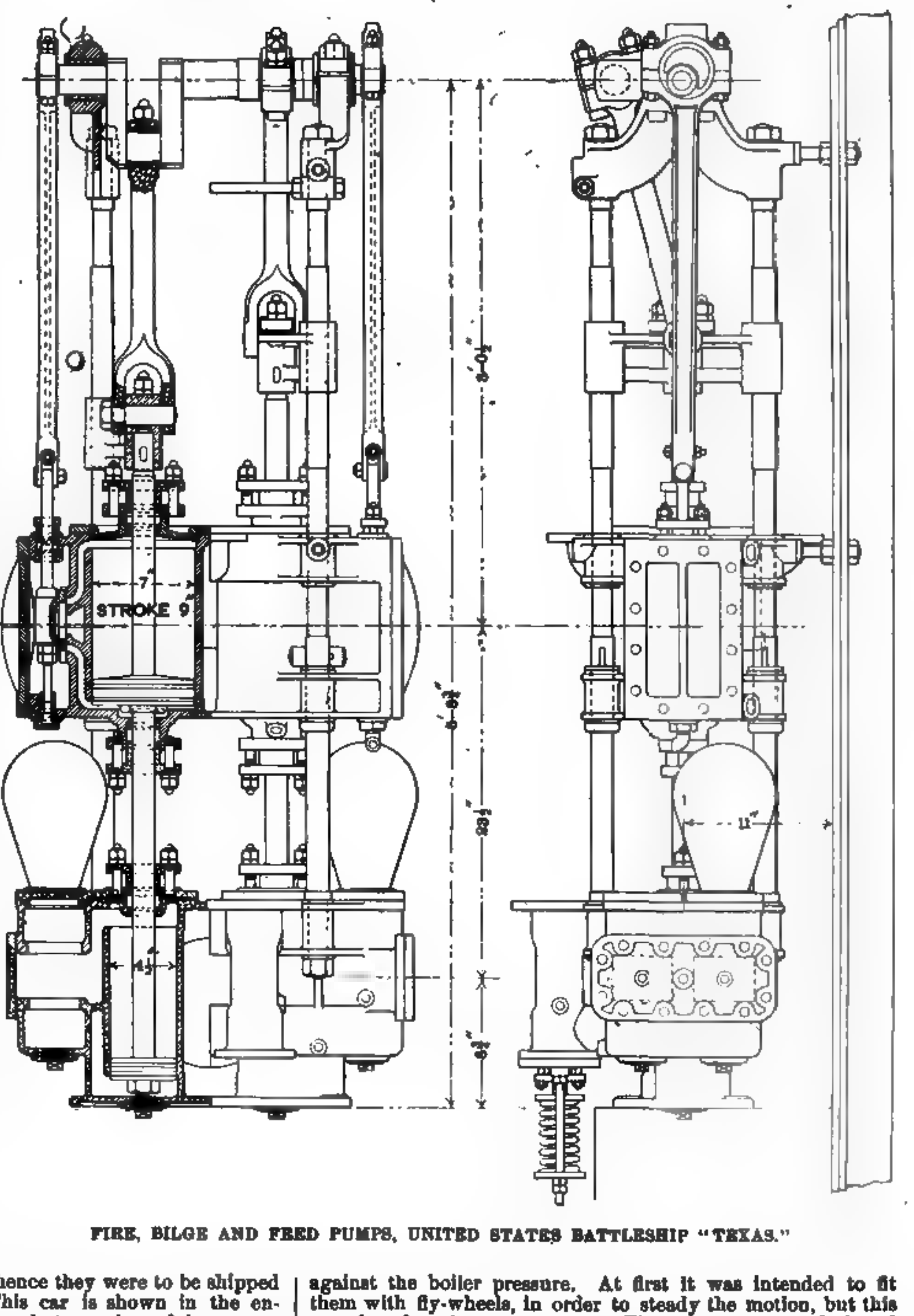
Each boiler is further provided with zinc protectors. There are 66 rolled zinc plates, each 8 in. × 16 in. × $\frac{1}{2}$ in. in each boiler. They are bolted to wrought iron straps clamped to the stays. Each strap is filed bright where it comes in contact with the zinc and stay, the latter being also filed bright at the contact point. After they were bolted in place the outside of the joints were made water-tight by paint or cement.

After the boilers were finished at the Richmond Locomotive Works, it was necessary to construct a special car in order to transport them to a wharf on the James River, whence they were to be shipped to the Norfolk Navy Yard. This car is shown in the engraving that is reproduced from a photograph, and is on page 207. As there is a tunnel between the works and the wharf they were obliged to make the car very low. To accomplish this they took two ordinary diamond trucks and fitted a frame composed of heavy timbers around the outside, keeping them down as low as possible. Heavy pieces at the truck bolsters carried the center plates, and the boilers were carried at the center.

Closely allied with the boilers are the feed-pumps, and those illustrated were designed by Mr. Mellen for this particular place. Room is very precious on the *Texas*, and the pumps are made to occupy the least possible amount of space. The same pattern was used for feed, fire and bilge-pumps, there being 12 all told of the design illustrated. There is one in each fire-room for main and auxiliary feed-pumps. The dimensions are:

Diameter of steam cylinders	7 in.
" " water "	$4\frac{1}{2}$ "
Stroke	9 "

They are duplex pumps with cranks set at right angles, and they are capable of delivering 100 galls. of water per minute against the boiler pressure. At first it was intended to fit them with fly-wheels, in order to steady the motion, but this was found to be unnecessary. The pumps are so designed that the packing of the water pistons can be reached from the tops of the cylinders. The main feed-pumps, which are in the after fire-room, are fed from the feed tanks only, but the auxiliary pumps, located in the forward fire-room, are connected to draw from the sea, feed tank, bilge or boilers at will, and to deliver either into the auxiliary feed-pipe, fire main or overboard. As fire-pumps they can be worked under a steam pressure of 60 lbs. per square inch. Each pump has a breadth over all of 2 ft. 4 in., and stands 1 ft. 10 in. out from the partition against which it is bolted.



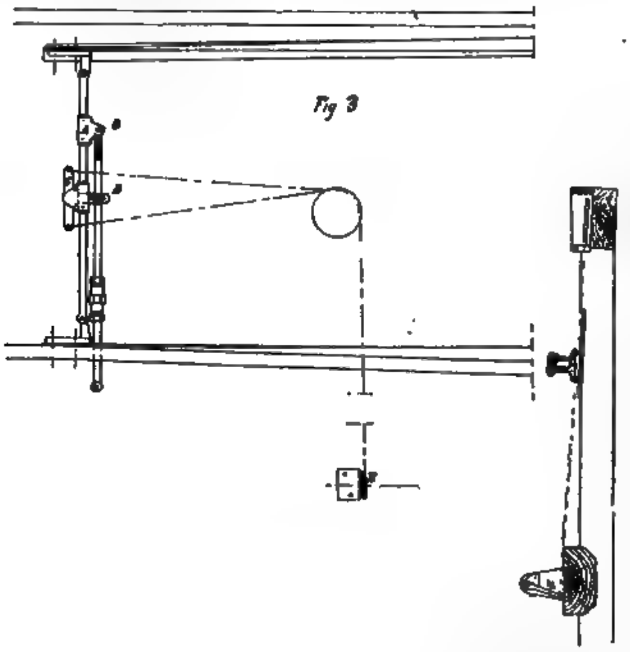
FIRE, BILGE AND FEED PUMPS, UNITED STATES BATTLESHIP "TEXAS."

SIGNAL APPARATUS IN USE ON THE GRAND CENTRAL RAILWAY OF BELGIUM.*

By Leopold Kirsch.

(Continued from page 163.)

Special Detail Effecting the Contact of the Points.—We have said that the central eccentrics ought to effect a contact—that is to say, they ought to bring up against the main-rail without causing the destruction or the serious wearing of any important part whatsoever of the operating mechanism of the switch apparatus. Furthermore, the homing of an eccentric ought never to be beyond the control of the switchman. Finally, the final wearing, which is caused by this striking of a point, should be easily and quickly taken up. We have



fulfilled these conditions to our own satisfaction in the following way: In our eccentrics the two points are fastened together by three connecting tie-bars. We have fastened the first of these tie bars to the operating rod by means of a fixed fork, *A*, and a pin, *B* (fig. 3). This pin *B* is strong enough to guarantee the solidity of the two tie bars, which are fastened together under ordinary circumstances; but it is not as strong as the other parts of the operating mechanism, so that in case of cramping it is destroyed by shearing without resulting in any serious injury to the other parts. It is enough to have a number of these pins on hand in order that the breakages which are thus caused may be quickly repaired.

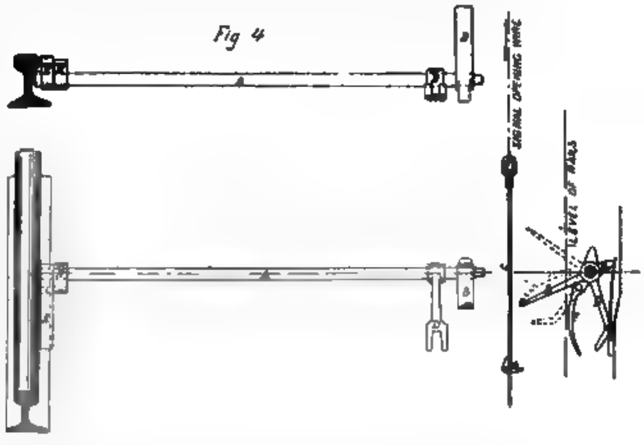
In case of running through the points the operating rod remains motionless while the connecting bars are displaced with the points. We have profited by this fact to notify the signalman of every case which occurs, even though it may be in his immediate neighborhood. In order to do this, the connecting bar carries a piece, *C*, in the form of a T, which turns about the crossing point of its two branches. Two of these are placed parallel to the connecting bar, and end in an eye which is fastened to the end of a steel wire. The third arm is placed at right angles to the tie bars, and has an oblong opening at its end, into which a button fastened on the operating rod can move. The two ends of the wire or chord, above referred to, unite into one, which passes over a pulley and is fastened to the end of the shears *E*, between the blades of which the transmitting wire of the mechanism passes. When everything is working normally the tie rods and the operating bar move together in parallel directions, consequently the part *C* moves, but does not turn about its center, and the end of the shears remains immovable. But if it strikes, the tie bar slides over the operating bar, the piece *C* turns and pulls upon the chord, so that the shears closes its jaws and cuts off the transmitting wire. Finally, in the cabin the locking bar falls and fastens the levers which control the switch points that have just been injured. In order to bring the apparatus back into good working condition, a piece of steel wire of a given length, supplies of which are kept in the signal cabins, is put back to take the place of that portion which was cut off in the shears.

Special Arrangements for Temporarily Locking the Points.—It is sometimes necessary to have such a relationship between the signal and an eccentric, that the position of the point cannot be changed after a signal has been set to clear until the train has passed the said point. It is especially desirable that this should be done at small stations on single-track roads. The arrangement used should be such that only the single opening wire for the signal can be used; it ought to be independent of the closing wire of the signal; finally, it ought to be brought back into the normal position by the train or by hand.

To satisfy all these conditions of the problem, we add an operating mechanism to the eccentric consisting of the following parts. On the horizontal rotating shaft *A* (fig. 4), located at right angles to the track and close to the part which moves the eccentric, we key a crank, *B*, and a fork, *D*, to one end, while at the other end we have a cam, *H*, which can move in one direction only, and the pedal *E* that turns freely about the shaft *A*. The opening wire of the signal passes along the plan of rotation of the crank *B*, above which it is replaced by an iron bar, *C*, carrying a small tappet, *c*, which can only turn in one direction. When the opening wire is drawn in the direction of the arrow, the tappet *c* engages the crank *B* and carries it over into the position indicated by the dotted lines; when the wire is hauled in the opposite direction, the tappet *c* lies along the bar which passes above the crank *B* without carrying it with it in its movement.

The shaft *A* is turned by the movement of the crank *B* and raises the fork *D*, which thus locks the operating portions of the point, and the pedal *E* rises until it occupies the position indicated by the dotted line. When the train reaches the point it pushes the pedal *E*, the fork *D*, and the crank *B* back into their original position, and the point is again free. If, for any reason, a signal, which has been set to clear, should be brought back to the danger position before the train passes there is nothing to hinder it; but, in spite of the closing of the signal, the point will be left locked in the position which it occupied at the time the signal was opened. In order to free it a man must go to the point, and with his foot or hand push down the pedal *E*. On the other hand, if the signal has not been set to clear, it will be necessary to raise the pedal *E* by hand, and then the latter will fall of itself into its proper position, and the point will be free.

Safety Device for Preventing a Premature Movement of the Point.—When an eccentric is some distance from the operating station or some obstruction intercepts the line of sight, it is frequently quite difficult for the signalman to determine with certainty whether the entire train has cleared the point or not. In cases of this kind, in order to prevent a premature movement, we set a detector bar, *A* (fig. 5), ahead of the point, and move it by the same method of transmission as the point itself is moved. This bar is carried by a number of larger or smaller bell cranks *B*, turning about their angle *G*; all these bell cranks are coupled together by a bar, *H*; the bar can be moved from top down or from bottom up, but by the means adopted the movement is communicated uniformly to all parts of the bar without producing any dead points. The center of



rotation *A*, of one of the end bell cranks *B*, is extended out toward operating mechanism of the points, and ends in this direction in the crank *D* provided with the cam *E*. The weight of the bar *A* tends to push the cam *E* up, and this consequently presses against the eccentric *F* that can describe a complete revolution, and which is rigidly fastened to the pul-

* Bulletin of the International Commission of the Railway Congress.

ley G, having two grooves over which the transmission wire passes. While the transmission wire is doing its regular work, the pulley G and the cam F turn on themselves, and the cam E is lowered and then rises while the bar A is rapidly lifted. It remains motionless for a certain length of time, and then comes back to its initial position. The perimeter of the cam F is so outlined that the three periods of movement of the bar A correspond respectively to the three periods of movement of the operating mechanism of the point. If a car wheel is above

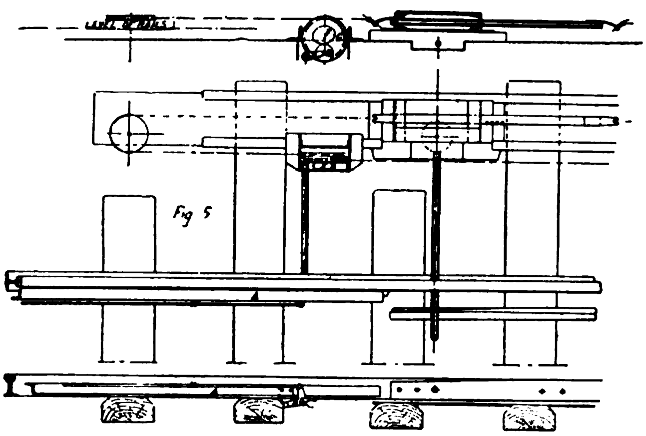


Fig 5

any part of the bar A it cannot rise; the cam E, and consequently the cam F, the pulley G and the transmitting wire are locked before the point begins to move.

By grouping these different details it is possible with a single lever to operate the point, and at the same time do away with every false motion and prevent a premature movement of the point.

Mechanism for Operating the Semiphore Signals.—The ends of the two transmitting wires are fixed respectively to a point on the outside perimeter of the pulleys A and B (fig. 6), which turn freely on the same shaft, located at the foot of the mast. Each of these pulleys carries a small central drum about which a wire that runs up along the mast is bent in a direction opposite to that of the transmitting wire. One of these others is attached to the ends of the click lever C. This click C, which can turn and which rests freely on the shaft of the arm, ends at one end in an eyelet C, to which the closing wire is fastened, and at the other end in a hook, H, over which a loop in the opening wire is hooked. This click also carries a button, E, which slides through an oblong opening made in the crank D, which is keyed to the shaft of the semiphore. The weights of the arm and its counterweight are regulated, so that the arm has a constant tendency to rise into the danger position. During the first third of the stroke of the operating wire the arm remains motionless, the click simply turns about the shaft of the arm, and its button E moves down to the bottom of the slot in the crank D; then the connections are made, the click lever continues to turn, while its button E draws the crank D down with it, and consequently the arm is also moved.

Whatever may be the position of the arm at this moment, if the transmitting wire is broken, the click leaves the shaft of the arm and turns about the button E, and the arm remains in or is automatically drawn up to the danger position. Until the broken wire is repaired the arm remains rigidly fastened. As the locking bar has also fallen in the cabin at the same time, the signalman is notified of the injury which has taken

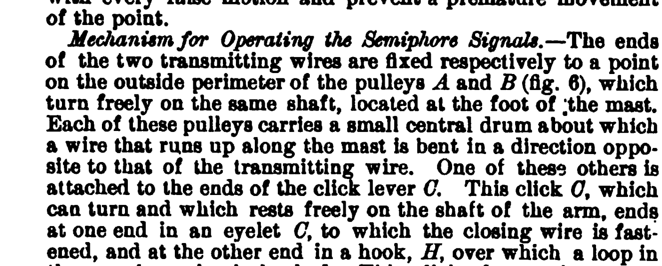


Fig 7

place, and it is rendered impossible for him to set the signals in such a way that there can be any danger whatever.

Mechanism for Operating Distance Signals.—Our distance signals are composed of a rectangular disk, fixed upon a vertical mast which can turn through an arc of 90°, and are always locked in either one or the other of their extreme positions by the operating mechanism. The latter is similar in every particular, even in its dimensions, to the operating mechanism of the points which we have just described; and it differs only in principle in certain details intended to bring the signal back to danger in case of the breakage of either of the transmitting wires. The rack bar ends in two floating levers A and B (fig. 7), which can turn about either of their extremities, and are fastened to each other by the rod G. The floating lever A is provided with an eye D, into which the end of the closing wire is fastened, and the floating lever B carries an open hook E over which the loop at the end of the opening wire is hooked. The distance of the eyes from the points of rotation of these floating levers is regulated, so that under normal conditions the two floating levers are inclined as shown in the engraving. If the opening wire breaks when the signal is at danger, the signal remains motionless; if, at the moment of rupture the signal is at clear, it is immediately drawn back to the danger position.

If the closing wire breaks, the two floating levers A and B turn about their inner end, and the eye of the opening wire slips off of the hook E. If at this instant the signal is at danger, it remains there; on the other hand, if it is standing at clear, it is drawn up to danger by the small counterweight F. At the same time the signalman is notified of the fact by the fall of the locking bar, which fastens all of the levers which are connected with this movement.

Expansion Compensator.—In order to put our transmissions outside of the pale of the influence of the variations of temperature, we have had recourse to an arrangement shown by the accompanying fig. 8. Each of the two transmitting wires passes over three pulleys A, B, C. The two pulleys A and B turn about fixed shafts. The shaft of the pulley C can be displaced vertically; it is placed in a stirrup, which is constantly pulled down by the counterweight E. This counterweight is hung on the end of a steel chord which passes over a hauling pulley, D, carried by the stirrup, and whose opposite end is fastened at F. Finally, the stirrup is provided on its lower side by the lateral spurs H; it carries the pulleys C and D of the two wires belonging to the same system of transmission, and it moves between two vertical guides which are provided with a series of teeth for the purpose of checking its motion.

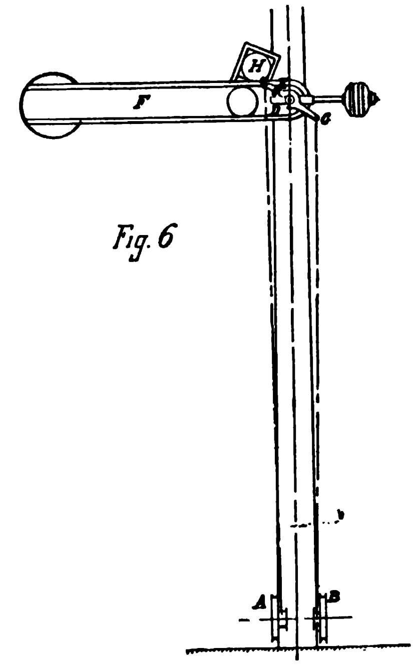


Fig. 6

When it is at rest the two wires have practically the same tension, and the stirrup which hangs almost vertically can move freely between its two guides; the wires can then lengthen or shorten at will. When a strain is put upon one of the wires the equilibrium is broken and the stirrup is swung to the right or the left, until its spur catches in one of the lateral teeth of its guides. The stirrup then becomes fixed, and its rigidity increases with the strain that is put upon the wire. By using a convenient spacing between the pulleys A and B and varying the weight of the counterpoise E more or less, according to the length of the transmission, it is possible to keep the wire under a constant tension, or at least to render the variations between the extreme tension so insignificant as to be practically of no account. This compensator, although very light, is very strong. It is inexpensive; its action is constant, and it is subject to no disarrangement. It can be placed in the narrowest passage allowed for the swinging of the wires either below the ground or above.

Owing to the apparatus which we have just described, and in view of the efficiency which has been demonstrated by ample experience, we believe that it may be said that the apparatus used by the Grand Central Railway of Belgium furnishes

an entirely satisfactory solution of the problem of operating signals and points at a distance by means of wire transmissions. The first applications were made for small stations on single-track lines. In many of these small stations the local traffic is insignificant. Nevertheless, the increase in traffic and the amount of switching of trains required the presence of a man at each end of the station to operate the entrance signal and the entering points. These men were unoccupied during the greater portion of the day. The use of the apparatus which we have just described permits the operation of the eccentrics for the switches and the signals for entering and leaving to be brought together in the office of the station

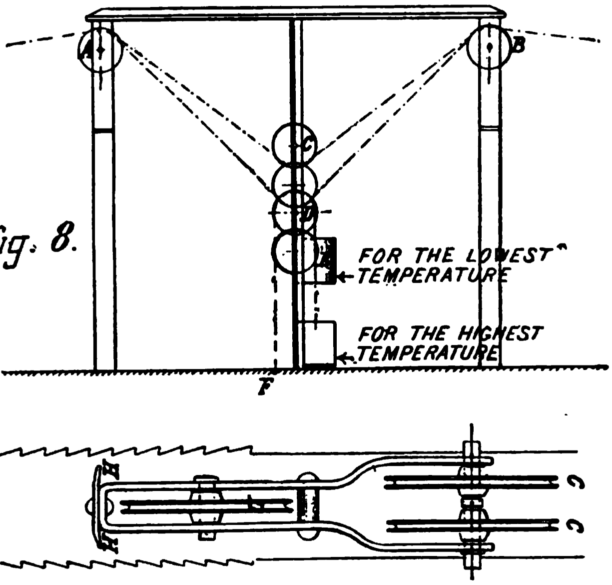


Fig. 8.

master or near it, and their operation be intrusted to the station agent. With a six-lever apparatus, costing on an average about $1000, it is possible to save the wages of one man, besides *considerably increasing the safety of the service.* The management of the Grand Central Railway of Belgium has also extended the applications of the apparatus in question, especially in the stations at Vlodrop and Maestricht. In the first case the signals and corresponding points were not only brought together, but the operation of different eccentrics were placed upon a belt-line track that was used in making up trains.

HYDRAULIC BOAT LIFTS.

By G. Braet.

It is well known that locks as ordinarily constructed have two very serious disadvantages—namely, the slight difference in level possible between the two sections of the canal and the large consumption of water. These disadvantages are especially felt where it is necessary to have a very considerable difference in level in a short length, and where water is frequently lacking for feeding the locks and thus raising or lowering boats from one level to the other. The engineers of bridges and highways in France have been compelled, in certain instances that were particularly difficult, to resort to other means, and have designed machinery for transferring boats from the upper level to the lower level and back again in some other manner than by that of locks—that is to say, in some other way than by allowing the boats to settle down by lowering the level of the water. Up to a very recent period it was only in America, Germany, England and France that systems of this kind have been adopted in any way. In America on the Morris Canal, and on the Continent of Europe in the Prussian Oberland on the right bank of the Vistula, boats have been raised on a car moving up an inclined plane. In Scotland, on the Mouckland Canal at Black Hill, boats have also been raised, in a cradle on wheels, up an inclined plane.

A later system, built after the plans of the well-known English engineers, L. & E. Clark and G. Standfield, and which in our opinion is fully as well designed and no less practical, has been built near Nortwich at Anderton in Cheshire, England. It consists of a cradle wherein the boat is lifted perpendicularly by a piston driven by water power.

The same system of Clark lifts, similar to those of Standfield, was adopted in 1882 in France, at Fontinettes, in the Department of the North, on the Naufosse Canal, effecting a communication between the port of the Pas de Calais with Lille and Belgium on one hand, and Paris and the basin of the Seine on the other.

In 1888, and we think this is the most recent application which has been made of this kind of installation, the Central Canal in Belgium, which connects the canal from Charleroy to Brussels with the canal running from Mons to Condé, has also been provided with hydraulic lifts for boats built after the Anderton type, but slightly modified in certain details.

Let us see, then, of what the lift or hydraulic elevator designed by Messrs. Clark and Standfield consists. This installation practically includes two cradles, kind of immense rectangular basins full of water, tight at the sides and closed at the ends by very tight gates, so that no water can escape. Each of these cradles or basins is carried at its center by a piston which moves in a large cylinder. The two presses are connected in such a manner that the two cradles hold each other in equilibrium. When a communication is opened between the two by means of a pipe provided with a cut-off valve, the two cradles can be alternately raised or lowered to the top or bottom level. In order to accomplish this the upper cradle is loaded, and the actual method of doing this is to put more water in so that it thus becomes the heavier, breaks the equilibrium, and descends to the lower level, driving the other cradle at the same time to the upper level. The elevators are thus operated like an immense Roberval balance, whose platforms are these metallic cradles.

At Anderton the dimensions of the cradles are as follows: Length, 75 ft.; breadth, 15 ft. 8¼ in.; depth, 6 ft. 1½ in. When the cradles are at the lower end of their stroke they are immersed in the lower lock. At the upper end they abut against a metallic aqueduct against the face of which a round piece of rubber is fastened having a diameter of 3 in. The rising cradle comes up against this rubber, compressing it, and thus forming a tight joint. The pistons of the cradles are made of cast iron, and the hydraulic cylinders in which they move are of the same material. The weight of the contained water is about 240 tons. At the two ends of the cradles the iron gates slide in vertical grooves and rest against a rubber packing by which the tightness of the basin is obtained. In order to prevent the cradles from turning they are guided in their vertical movement at the four corners by cast-iron shoes sliding against columns of the same material.

The lift at Anderton was put into service in July, 1879, and worked regularly up to April 18, 1882, at which time it was accidentally disabled by the breakage of one of the cast-iron cylinders, an accident which was soon repaired. The fracture that occurred, as was shown by an examination of the cylinder after the accident, was due to the bad quality of the cast iron and to the fact that the foundations at the bottom of the cylinder were made of soft wood that had crushed in, thus developing strains in the metal. After the necessary repairs had been made it is reported that the lift at Anderton continued to give very good results in service.

Messrs. Clark & Standfield have furthermore perfected their system by doing away with the immersion of the descending cradle into the lower lock, by causing it to descend into a dry basin, and by balancing the two cradles in their every position by means of compensators. The expense of the construction of the Anderton lift was:

Metallic portions	$139,840
Foundations and masonry	90,060
Total	$229,900

The time for lifting a boat with the Anderton lift is about eight minutes, and it requires one hour and 30 minutes at Rounton, near Anderton, to pass over the same difference in level by means of locks.

At Fontinettes, in the Department of the North of France, where the difference in level is 43 ft. 8¼ in., the descending cradle drops into a dry basin, and the two cradles are held in equilibrium by means of compensators. The dimensions of these cradles are as follows: Length, 132 ft. 10¼ in.; breadth, 18 ft. 4½ in.; depth of water, 6 ft. 6¾ in.

The dry joint between the aqueduct and the end of the cradle is obtained by means of a kind of rubber bolster fastened to the face of the aqueduct, and which is inflated by means of compressed air, thus closing the joint between the cradle and the aqueduct. The gates at the end of the cradle are raised vertically by hydraulic presses which give them a very rapid movement. The danger of using cast iron for the

manufacture of the presses having been brought into notice by the Anderton accident, the Fontinettes presses are made of rolled steel. The cylinder is formed of rings rolled without any weld of a rectangular section, having a thickness of 2.2 in. and a height of 5.5 in. The rings are let into one another for half their thickness by a joint .2 in. in height. The ties connecting the upper and lower sections are made of hammered cast steel. The steel used for the manufacture of the sections has a tensile strength of 85,300 lbs. per square inch, and has an elongation at the point of rupture of 12 per cent. In order to make sure that the tightness of the press is as perfect as possible, an internal lining of copper has been put in that has a thickness of .1 in. and is made of a single piece. This system of elevator is very expensive, rising to a total of $210,000, which may be itemized as follows: $120,000 for the metallic portions and $90,000 for the foundations and masonry.

According to the reports the time of passage of boats at Fontinettes is not more than about 19 minutes by the lift, while previously it was one hour, 49 minutes when done by means of five locks. The saving in time thus realized is, therefore, a very important one.

In Belgium, on the Central Canal at Louviere, the difference in level overcome by means of hydraulic lifts is about 217 ft. 2 in. in a distance of 5 miles. Of these lifts, of which there are four, and which have a capacity of lifting boats of about 390 tons capacity, three have a possible height of fall of 55 ft. 6.5 in., and the fourth has a height of fall of 63 ft 7¾ in. The cradles have a length of 142 ft., a breadth of 19 ft., and a depth of water of 7 ft. 10½ in. They are guided in their vertical movement independently of the center guiding, by metallic columns bound together by means of handsome foot-bridges that give it great strength in all directions. The pistons, which are of cast iron, as in the other lifts, have a total height of 64 ft., a thickness of 3 in., and an external diameter of 6 ft. 6⅝ in. The total weight of each of them, including the head, is 187,400 lbs. As for the cylinders, they differ from the lifts at Anderton and Fontinettes, in that they have an internal diameter of 6 ft. 9 in., and are composed of nine cast rings with a height of 6 ft. 10½ in. and a thickness of 4 in., with steel hoops having a thickness of 3¼ in.

These hoops are placed over the joints hot, and have a thickness of 2 in., a height of 6 in. The steel of which they are made has a tensile strength of 64,000 lbs. per square inch, showing an elongation of 20 per cent. at the point of rupture.

The cylinders rest on a timber foundation having a diameter of 13 ft., which rests on a foundation of broken stone and cement. The gates at the top and bottom of the cradles are raised vertically by means of chains driven by special turbines. The tightness of the joint between the cradle and the aqueduct and the metallic canal at the bottom is obtained by means of metallic joints with rubber packing, which press up against the ends of the cradles, and are moved parallel to each other in inclined planes by means of hydraulic presses. The packing at the bottom rises to form the tight joint, while that at the top drops. In case of accident, or when it is necessary to repair a cradle, the other can work independently. In order to do this two turbines of 69 H.P. each pump water into an accumulator under a pressure of 40 atmospheres, and this drives the piston of the lift.

The metallic portion of the lift at Louviere cost $163,400; the foundations and masonry cost $76,000. The total length of time required for the passage of a boat, both raising and lowering, averages eight minutes. The system which it replaces at Louviere had five ordinary locks, and consequently it is readily seen that a very great saving of time is obtained.

The preceding descriptions are, for the most part, taken from a paper on "Hydraulic Lifts for Boats," by Mr. Ch. Fréson, Engineer of the Société Cockerill, and published in the *Moniteur des interêts Matériel.*

THE RAM, IN ACTION AND IN ACCIDENT.

A PAPER was read, recently, by Mr. W. Laird Clowes, at the Royal United Service Institution in London, of which the *Times* gave the following report:

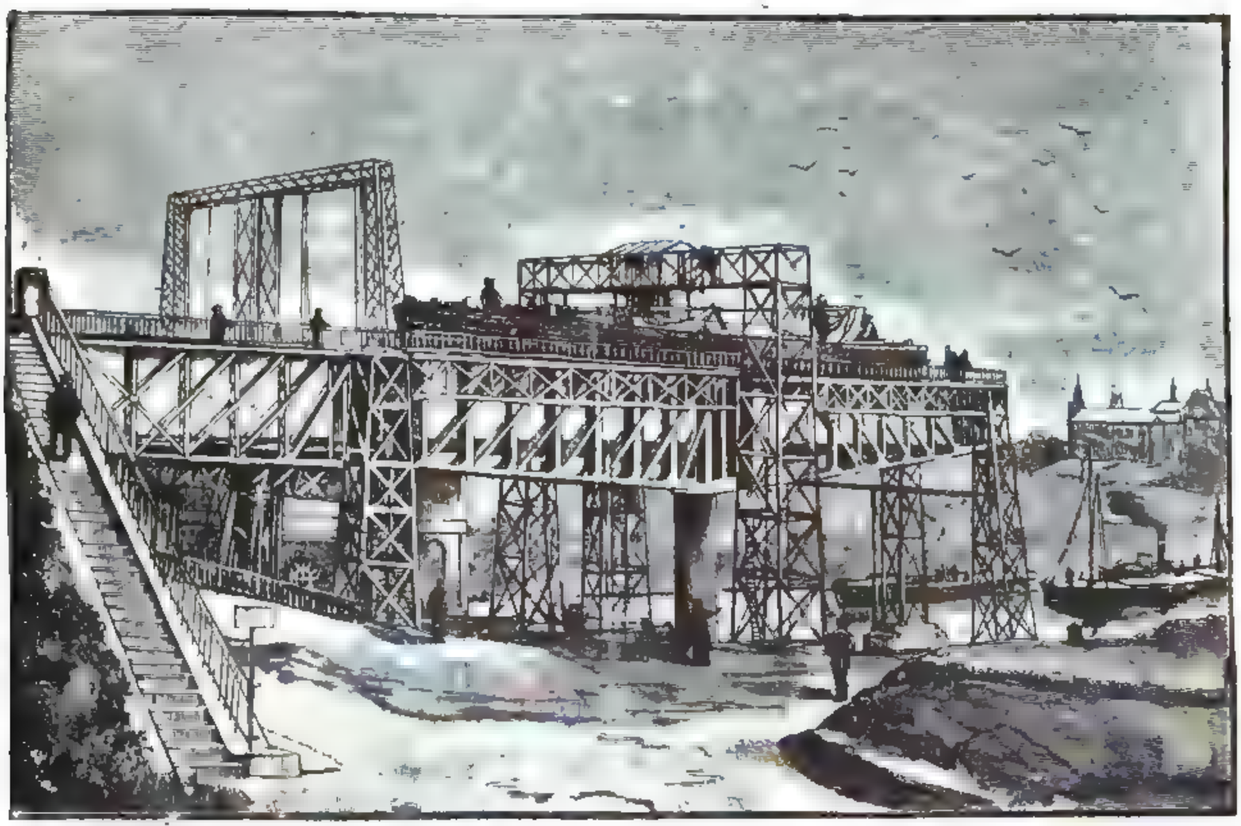
"I have heard naval officers, of all ranks from the lowest to the highest, and in this theater as well as elsewhere, express themselves in very sanguine tones concerning the future of the ram in naval warfare. I do not by any means intend to imply that all naval officers appear to believe to the same extent in the efficacy of this weapon. But I have known many, and among them officers of great experience at sea, who by their utterances suggest that, given slight superiority of speed and good handling, one ship can, without much difficulty, be made to ram another, even when the other is under full control and has plenty of sea room in which to manœuvre. This view of the capabilities of the ram has always, though in a loose and vague kind of way, been widely held; and I venture to think that the number of those who hold it has increased of late, and especially since last June, when the country had to lament the terrible and dramatic fate of the *Victoria*, and of so many of her gallant officers and men. But, recollecting as I do that naval officers and practical men have but little leisure for the study of the past, I am encouraged to lay before them a number of facts which I have assembled, and, with all deference, to indicate certain conclusions which those facts seem to force upon the mind of a very devoted, and I trust wholly unprejudiced, student of recent, as well as of ancient, naval history. I have made a detailed list of 74 cases of attempted ramming in what may be called modern naval warfare. I have included here all the cases, since the outbreak of the American War of Secession, on which I have been able to lay my hand. The list must not, therefore, be regarded as a list of selected examples. No doubt I have omitted some cases, but I have intentionally omitted none. The following summaries of the results to would-be rammer and intended rammed in the 74 examples are, I think, very suggestive. The results, so far as the ships intended to be rammed are concerned, were:

Previous situation of the ship attempted to be rammed.	Total number of cases	Effect upon the ship attempted to be rammed.				
		Nil.	Slightly damaged.	Seriously damaged.	Disabled.	Sunk.
Under steam with sea-room....	32	26	5	1	..	..
Under steam in narrow waters	32	9	9	3	2	9
Unmanageable........	4	1	..	1	..	2
At anchor............	6	..	4	..	..	2
Total...	74	36	18	5	2	13

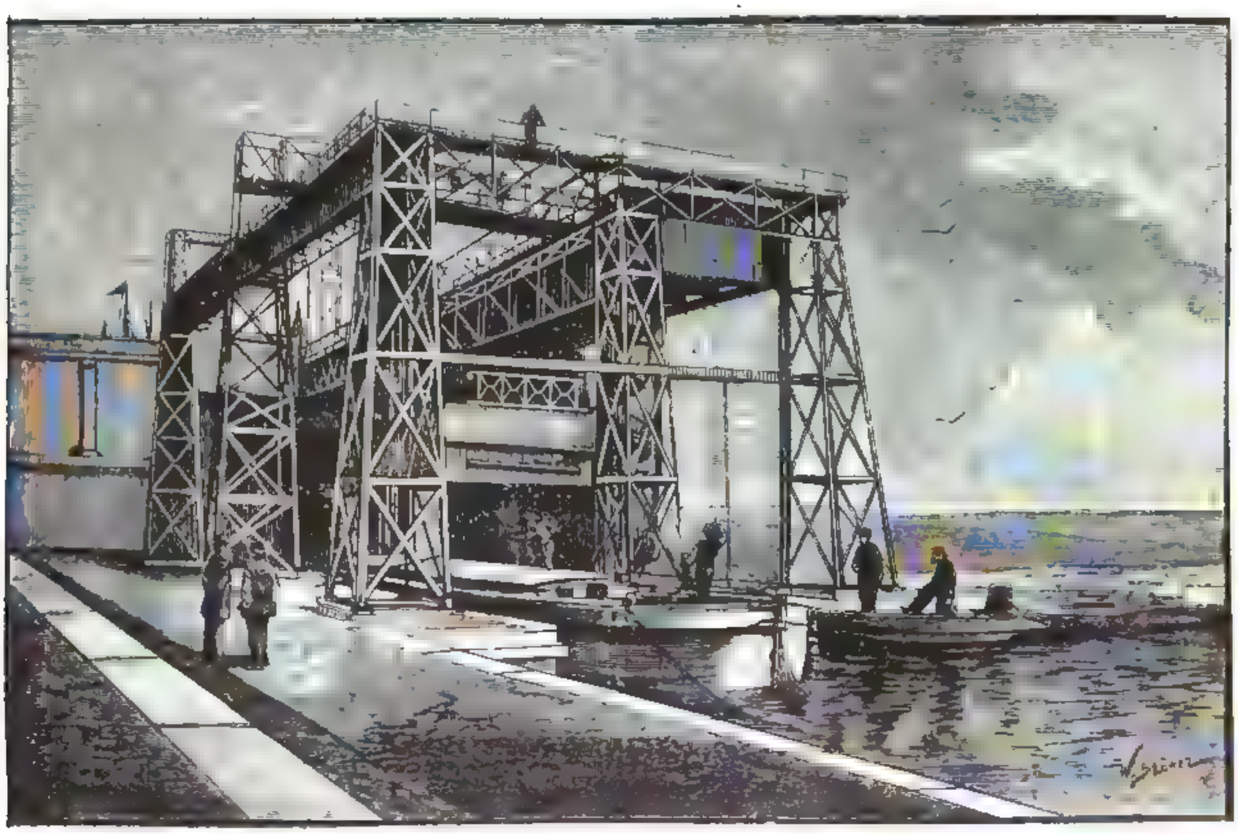
The results, so far as the ships ramming are concerned, were:

	Effect upon the ship attempting to ram.				
	Nil.	Slightly damaged.	Seriously damaged.	Disabled (run ashore)	Sunk.
Total number of cases, 74..	56	13	3	1	1

It will be observed that in 42 out of the whole number of 74 cited attempts at ramming, damage of some kind or other was done to one or both ships. In 24 of these 42 cases of effectual collision, the ramming ship received no damage worth mentioning; but in seven cases the ramming ship did herself about as much harm as she did to her opponent; and in seven other cases she injured herself even more severely than she injured her enemy. In no case did both rammer and rammed sink. All these cases occurred, of course, before the automobile torpedo had developed into anything like a perfect weapon, and most of them before the introduction of heavy breech-loading and light quick-firing guns. The obvious conclusions are somewhat remarkable. One is that, if two ships have sea room and be fully under control, it is actually more dangerous to try to employ than to try to escape the ram, and that, under these conditions, it is practically hopeless to dream of ramming effectively, since there is no recorded case of the operation having been performed, although it has been attempted at least 32 times. Another is that in such circumstances the rammer stands about the same chance as the rammed does of sustaining non-fatal injuries. Another is that the risks attendant upon ramming are the same whether the attempt be made at sea or in narrow waters. To what extent, it may be pertinent to ask, has the value of the ram as an offensive weapon been modified by the progress of the last 15 years? Will captains be more willing or will they be less willing to use it now, when the nearer they approach to the foe the more fatal will be the foe's quick-firing artillery, and when, at any range up to 800 yds., the effects of a torpedo are to be feared? And why should captains attempt to employ the ram at all when a torpedo, which is far less easy to avoid, and the use of which involves little or no risk to the user, will do all that is necessary? It may be granted that, having first disabled his enemy by gun-fire, a captain may ram with a reasonable probability of success; but in doing so he not only risks dam-



HYDRAULIC CANAL LIFT AT LOUVIERE, SIDE VIEW.



HYDRAULIC CANAL LIFT AT LOUVIERE, FRONT VIEW.

aging his own ship, encountering torpedoes, and bringing about needless loss of life, but adopts a course that leaves comparatively little chance that the enemy, which by other action might be reduced and taken, will ever be added to the effective sea forces of his own country. And, after all, a triumph is only half a triumph unless there be something to show for it. One of the few things that would go toward reconciling Great Britain to the agonies of a naval war would be the occasional spectacle of a foreign battleship brought into Spithead or Plymouth Sound, with the white ensign blowing out above the other flag. That is a sight which would animate the whole Empire, even in its hours of misery. If only on these grounds it seems unwise to destroy your foe when peradventure you can take him alive. And it is scarcely conceivable that a disabled vessel cannot be reduced and made to strike by the combined influence of gun-fire and the threat of the torpedo. I have cited 74 examples of the intentional employment of the ram. In those cases it has in one way or another brought about the loss of 15 ships only, including those which perished by their own act. But the ram unintentionally employed, both in action and in peace-time, has, I am afraid, been much more fatal. To my mind, if I may intrude an opinion by way of making an end, the main lessons of the past on the subject indicate—first, that to endeavor to effectively ram a ship that has sea room and that is under control is hopeless, even if she be of greatly inferior speed ; secondly, that a vessel that cannot be sacrificed ought never to be deliberately employed as a ram ; and, thirdly, that for ramming purposes a little ship is quite as good as a big one. Whether or not this last deduction points to the fact that, with a view to certain eventualities, this country would do well to build a few fast small craft intended for ramming only and of no particular value, I will not presume to say. But upon that point I am specially desirous to learn the views of those who are competent to speak about it.

"The discussion was opened by Admiral Nicholson, who said that the results of Mr. Clowes's investigations must have been somewhat of a surprise. The question of the efficiency of the ram was somewhat late, for the rulers of our own and every other navy had supplied almost all their ships with rams. To what use ought they to be put? The ram must be looked upon as a last resort, and he doubted whether in action the ram would ever be satisfactory. Excess of speed and also great facility of turning were required for the ram to be efficient. These two qualifications were rarely combined. In the battle of Lissa there were seven intentional attempts to ram. When the bow of a ship was on the broadside of the enemy there was no alternative but to ram. Were naval officers content with the rams of their ships? The experience of the *Victoria* and the narrow escape of the *Camperdown* were grave object lessons. He would suggest that the rams should be so finely and strongly constructed as to lessen as much as possible the dangers to which experience showed them to be exposed, or that the rams should be separable from the rest of the ship, or that the existing rams should be strengthened so as to make their use less dangerous than it now was.

"Lieutenant Baden-Powell, R.N.R., thought if the ram was so constructed as to drop off grave danger would be incurred if the ram did not fall off. His view was that the ram should be so strong as not to be torn or bent or twisted by the impact. His experience in the Admiralty Court confirmed him in the opinion of the necessity of water-tight bulkheads. Hundreds of ships were by these bulkheads enabled to get to port when their bows were completely crushed. The question was one of construction.

"Admiral Boys knew something of the *Camperdown*, on which he had a son. The danger in that case was not due to her ram, which was uninjured, but from the water tight doors not being closed in time. He did not believe in the possibility of a removable ram which should not cause weakness to the ship.

"The Chairman said that if he had his way there should be no rams, but a straight up-and-down stem. He agreed also with all that Mr. Baden-Powell had said. The *Arizona's* running into an iceberg with impunity was instructive. If she had been going 8 knots instead of 15 she would have been wrecked. The moral was, if you ram go as fast as possible. The result of the tables in the paper was very curious and instructive. It was strange to find that with ample sea room the rammer was in greater danger than the rammed.

"Mr. Arnold-Forster, M.P., thought that ramming should be confined to specially designed ships. Many of the cases cited by Mr. Clowes were cases of wooden ships. He had tried to get the views of mathematicians as to angles and relative positions of the two ships, but had never received a satisfactory answer. The class of materials used for the ram was an element in the calculation. But he did not think the record against the ram was so serious as the lecturer made out. The case of the *Arizona* was much in point. The ship went on steaming after the collision for several hundred miles. He remembered, too, the case of the *Northampton*; the rammer escaped unhurt. The *Grosser Kurfürst* and other examples were also in favor of the ram. Ramming was no new thing, but was well known to the Romans and to our own seamen and those of Venice in the Middle Ages. The damage to the *Camperdown* was done above the ram. She did not strike the *Victoria* with the ram alone, but the forward part became entangled with the armament on the *Victoria*. He did not believe in the form of ram-bow. The *Trafalgar* was rammed the other day by a torpedo, and had at once to seek refuge in dock. He agreed with the lecturer that where we had great ships with great guns the ram must not be prematurely used. The most powerful ship was helpless before a torpedo. No naval officer would hesitate to say that ships like the *Polyphemus* were almost as formidable a weapon in war as can be conceived. The ram ought not to be discarded, but employed under proper scientific conditions. In their present form many of our ships with rams were quite unfitted to act as ramming ships.

"Admiral Boys did not agree that a large vessel struck by a torpedo would necessarily be destroyed.

"Mr. Arnold-Forster admitted that he had somewhat overstated the case.

"Captain Barclay said the safest course for a vessel attacked by a torpedo was to be going for the enemy full speed. In those conditions the torpedo was apt to glance on one side. He had seen this result in the case of the *Polyphemus* in 1886.

"Mr. Laird Clowes, in reply, said that the latest battleship built in France—the *Brennus*—had no ram. He had intended to deal with the accidental use of the ram, but found it impossible to do so within due limits. The *Merrimac* did actually drop her ram, but was not prevented from afterward meeting the *Monitor*. The question whether ramming should be at full speed or not was one worthy of consideration. The modern school was in favor of it, but some years ago the idea would have been scouted. Mr. Arnold-Forster's citation of accidental ramming was scarcely to the point. The circumstances of such accidents were widely different from what would prevail in action. His conclusions were, first, that attempted ramming was not dangerous to the vessel attacked when there was plenty of sea room and the latter vessel was under control; second, that it was always dangerous to the ramming ship and sometimes to its enemy in narrow waters; third, where the ship rammed is not under control, the operation is not only dangerous, but unnecessary, as the proper course would be to capture the helpless enemy; fourth, accidental ramming is exceedingly dangerous, and the ram was in fact a weapon more dangerous in peace than in war; fifth, mere superiority in speed would not insure success to the attacking ship; and sixth, it was important to bear in mind that foreign countries were building vessels with the special object of using the ram."

STEAM STEERING GEAR.

A STEAM steering gear which is very easily operated and very successful is now being manufactured by Wickes Brothers, of East Saginaw, Mich. It was designed by their mechanical engineer, Mr. Heyde, for use on one of the tugs in the Saginaw River, but has since been applied to other vessels, and will probably find an application on many of the larger steamers. By an examination of the engravings the construction and arrangements of the mechanism will be very readily understood.

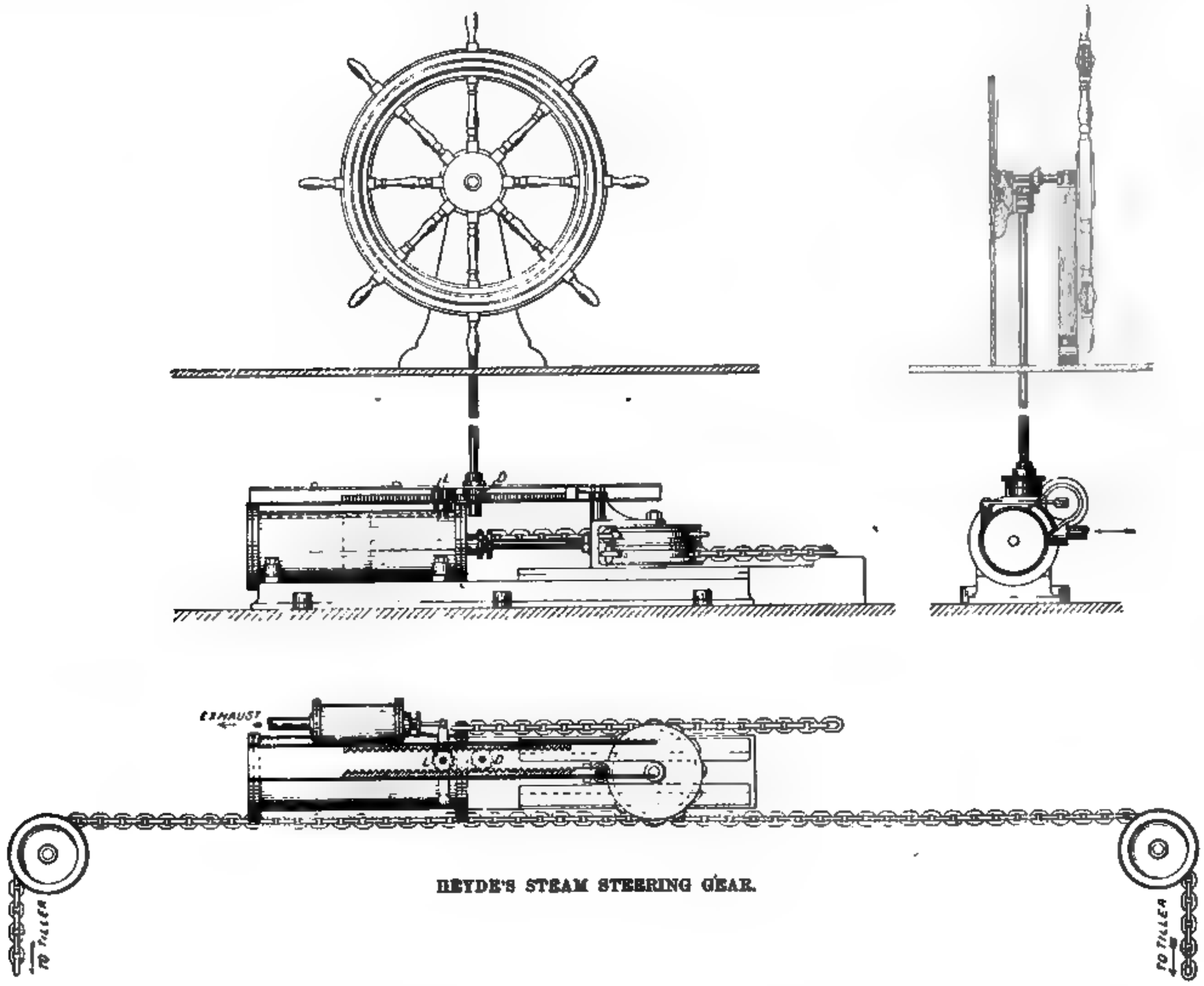
The wheel in the wheel-house carries on its shaft, between the supporting-post and the outer wall, a miter gear which meshes in with another gear on a vertical shaft that extends down to a point below the deck where the steam steering gear is located. The lower end of this shaft carries a small clutch, and below it a spur pinion, which is loose on the shaft, and is furnished with a clutch meshing in with the one already mentioned. Still further below this there is another pinion of the same diameter as the first, but keyed rigidly to the shaft. The sheaves, over which the tiller chains are run, are carried in a strap bolted rigidly to the piston-rod, and these chains, as will be seen by reference to the engraving, are so arranged that, for every foot of motion of the piston-rod 2 ft. of tiller chain are either slackened off or taken in. Over the top of the cylinder there are two racks, one of which is movable and the other is rigidly fastened to a stem carried by the strap of the tiller sheaves, and which moves backward and forward with these sheaves. These racks have teeth, each the width

of the pinions already referred to as being upon the vertical shaft, but the top edge of the movable rack is on a line with the lower edge of the rack attached to the piston-rod, so that the loose clutch pinion meshes in with the rack attached to the sheaves, while the pinion that is rigidly keyed to the shaft meshes in with the movable rack.

The valve is a piston valve especially designed by Mr. Heyde, and detailed illustrations of which we will publish in a future issue, in connection with engines built by the same firm. In this instance this piston valve takes steam at the center and exhausts at the ends, so that the motion of the valve for admission of steam is contrary to that of the ordinary D-valve, being in a direction opposite to that which it is proposed that the piston shall move. The valve-stem is moved by a rocker arm that is pivoted at one side of the cylinder, and at its central point carries a pinion that has a depth sufficient to mesh in with both a movable rack and the one attached to the piston-rod. If, then, the wheels turn so that the shaft turns in the direction of the motion of the hands of a watch as looking at it on the plan, it will be seen that the first motion is that the lower pinion keyed to the shaft will turn the movable rack to the right. As the piston is practically rigidly fixed in of the cylinder, and thus locks the piston so that the motion is comparatively slight. If it is desired to run the tiller hard over in either direction, it is simply necessary to keep the wheel revolving, so that the motion of the movable rack counteracts that of the rack fastened to the piston. When this is done the pinion on the rocker arm merely revolves and the valve remains in the open position, to which it was carried by the first motion of this rack.

It is impossible to give an idea of the delicacy of the adjustment of this apparatus without an actual inspection of the machine at work. It will readily be seen, of course, that the power required at the wheel is almost infinitesimally small, there being no strain in any way, except to move a perfectly balanced piston-valve, and with the leverage given this is of course almost imperceptible.

An indicator in the wheel-house shows the position of the tiller at all times. Various sizes are made for steamers of different lengths, but owing to the delicacy of adjustments and the direct action obtained, together with the multiplication of the power on the cylinder, these cylinders are very much smaller than those ordinarily used for steam steering gears.

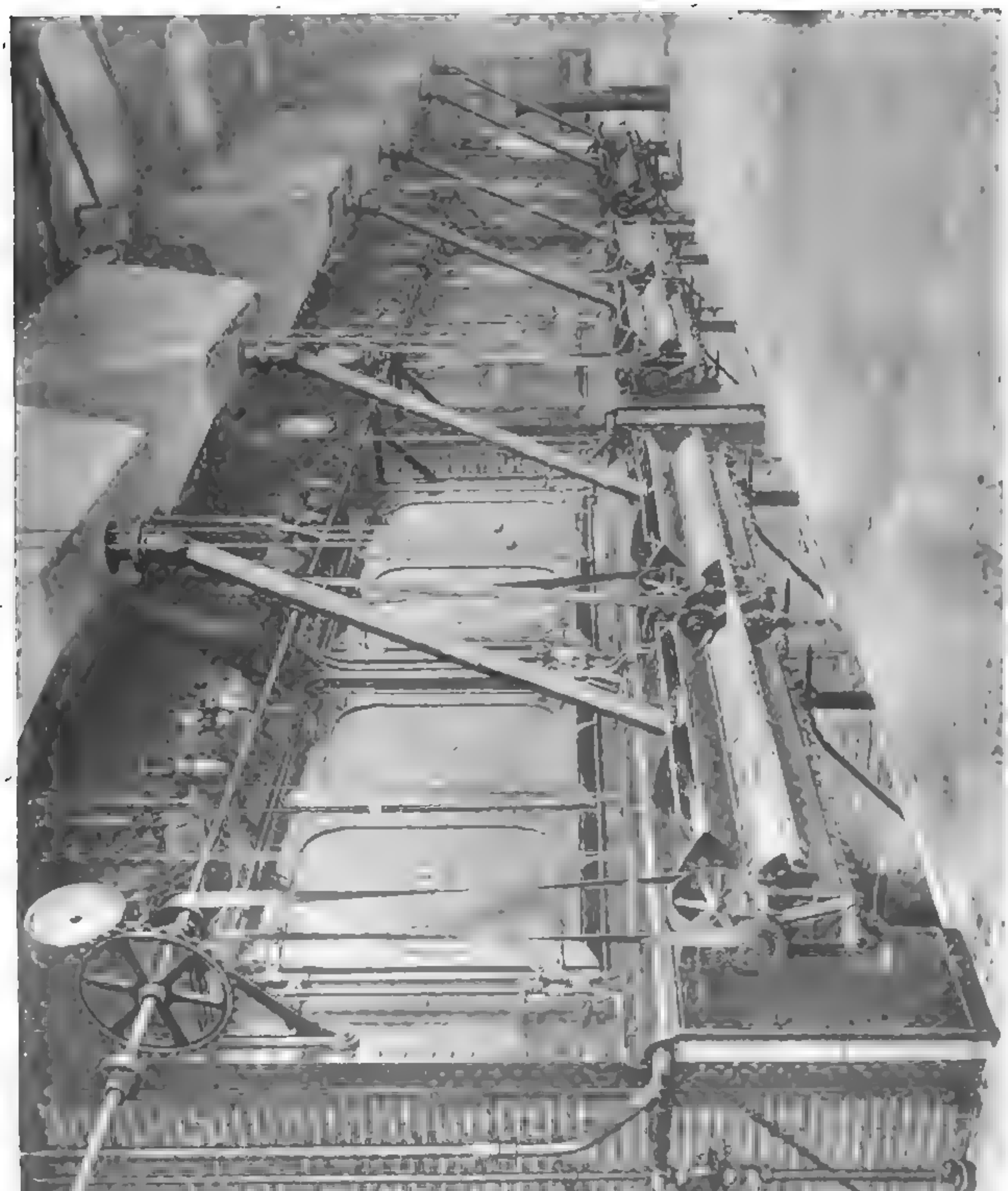


HEYDE'S STEAM STEERING GEAR.

its position, the rack fastened to it is also stationary. Therefore, as the movable rack is carried to the right, it turns the pinion on the rocker-shaft and also carries this rocker-shaft to the right. The valve taking steam at the center position opens the port at the right-hand side and admits steam to the right-hand end of the cylinder. This opens the exhaust from the other end and carries the piston to the left. The first movement of the piston is to draw in the tiller chains, and at the same time it turns the loose pinion on the vertical shaft, until it comes up against the straps of its clutch. At the same time, the vertical shaft being stationary, it holds the movable rack rigidly in position. Therefore, as the piston moves in it rolls the pinion on the rocker arm back with it and closes the valve. The moment the valve is closed steam passes over through a port similar to the Allen port, to the opposite end

BOILERS AND BOILER-ROOM AT THE BALDWIN LOCOMOTIVE WORKS.

The proprietors of this establishment have recently installed a new stationary boiler plant in their works, consisting of a number of Babcock & Wilcox water tube boilers provided with the Wilkinson Manufacturing Company's automatic stoker, appliances for handling coal and ashes automatically, and other improvements which make it one of the most complete boiler plants probably in the country. The boilers are on the second story of the building in which they are housed, which is quite contrary to all preconceived ideas and the old-fashioned principles relating to this subject. In this location there is plenty of light, and the rooms are much better ventilated than they would be on the first floor. The amount of light is



INTERIOR OF BOILER ROOM AT THE BALDWIN LOCOMOTIVE WORKS, EQUIPPED WITH BABCOCK & WILCOX BOILERS.

indicated by the engraving, which was made from a photograph taken in this room without artificial light.

We give a sectional view of the boilers, which have been described so often that no explanation of their construction, other than the engraving, is needed. We expect to give detailed engravings showing the construction of the stoker and other appliances next month.

MEETING OF THE MEMBERS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

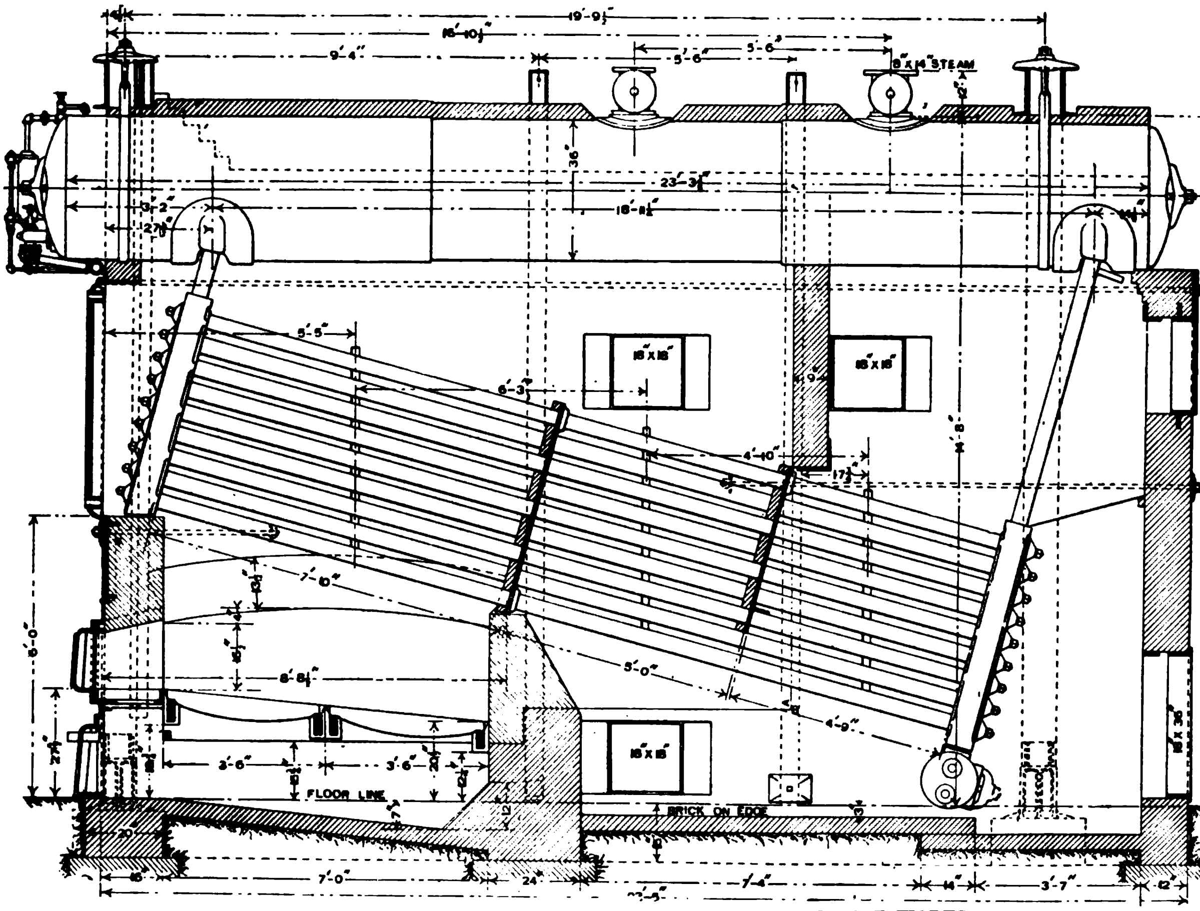
TESTING MACHINES.

The April meeting of the members of the American Society of Mechanical Engineers was held at the house of the Society in New York, on the evening of Wednesday the 11th, with Mr. C. W. Hunt in the chair. The paper of the evening was read by Mr. Tinius Olsen, and related to the recent improvements that have been made in his testing machines. Mr. Olsen spoke as follows:

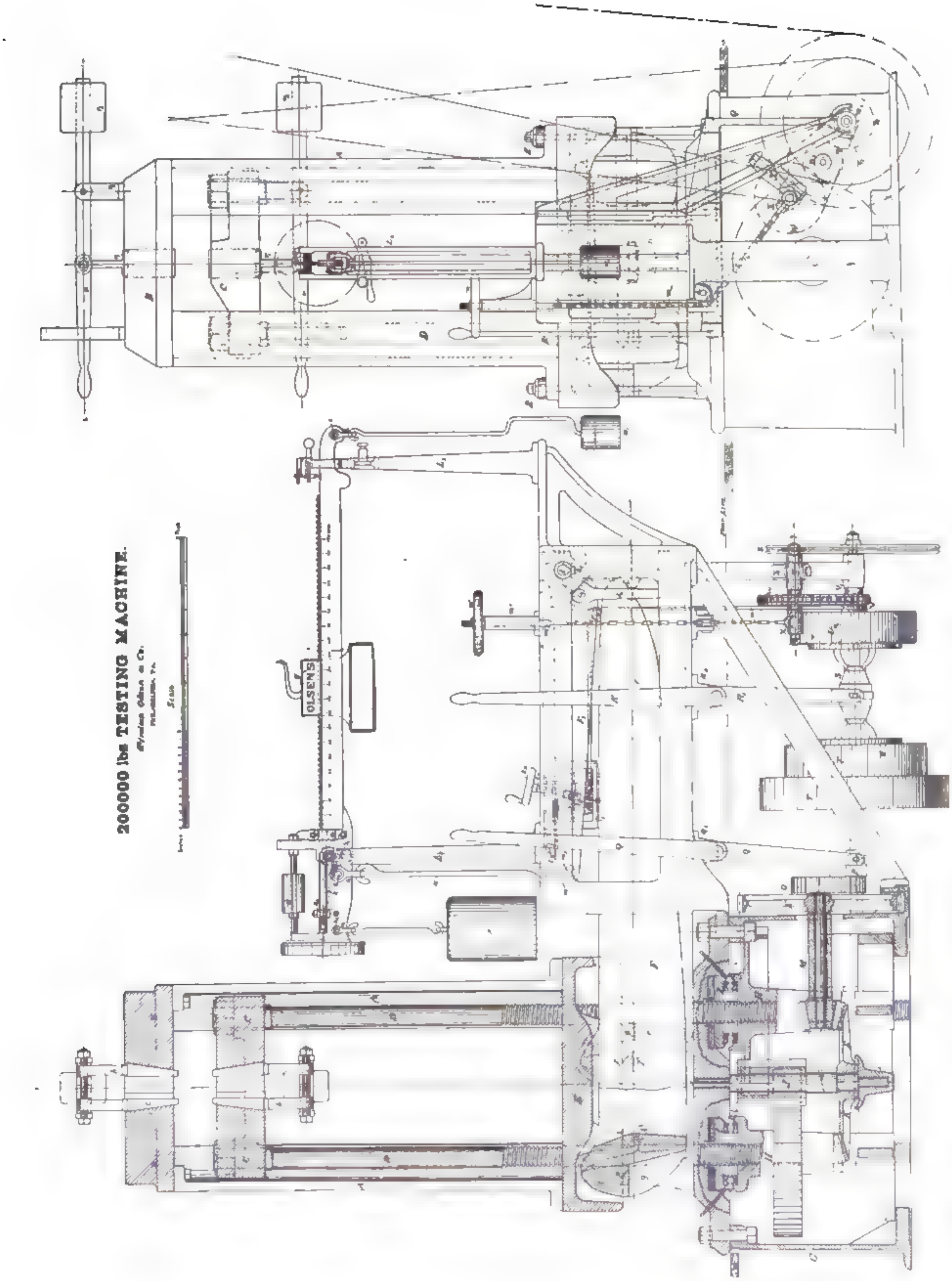
Mr. Chairman and Gentlemen:

The improvements which I more particularly propose to describe to-night will be better understood if the design of the machine to which they are so far applied is shown. Our first view is, therefore, of a machine as it is now very generally used in the rolling mills, steel works and other industrial establishments.

The ends of the specimen to be tested are secured in the cross-heads *B* and *C*, by the wedges operated and placed in the proper position by the balanced lever *r*. The lower movable cross-head *C* is secured to four screw-threaded rods *D*, to which a vertical motion is imparted by a train of gearing in the base of the machine, and the same is operated by power from the countershaft and pulleys *J* and *U*. The upper cross-head *B* rests upon four quarter-section columns *A*, which are supported on the scale platform *E*. Platform *E* rests on the scale levers *F F'*, which communicate the pressure exerted on the platform *E* through the intermediate lever F' to the beam where the pressure is balanced and recorded. In many machines the adjustment of the poise *q* is done by the operator turning a hand and cord, or a belt wheel placed in front of the stand L^2. In the view before you, however, the arrangement is shown for the automatic movement of poise *q*, which is now used in many places. The automatic movement is accomplished by a belt driven from the hub of pulley *U* at *V*; this belt runs vertically to and over guide pulleys *Q*, then horizontally to the speed-regulating cones 1^1 and 1^2; from cone 1^1 a small round belt transmits the motion over guide pulleys 1^3 vertically to the pulley *S*; which turns a shaft in a bracket secured to the beam; the grooved pulley *S* being so placed that the belt pulls exactly in line with the balancing pivot of the beam, and thus no irregularity in the tension of the belt during the test has any effect whatever on the sensitiveness or operation of the beam. From the pulley and its shaft *S* the motion is further transmitted to a small friction pinion, in the dial casing 3; this friction pinion is in constant motion during the operation of the machine. On top of the beam is seen one-half of a very large pitched screw 4, for moving the poise; this screw is extended into the casing 3, and on the end is secured a large disk and dial, which shows to the operator the smaller and fractional readings of the stress exerted on the specimen. The dial-plate, which is secured to the end of screw 4, is made to revolve by causing contact between it and the constantly running friction pinion, thus turning the screw 4 which moves the poise *q* on the beam. This contact is effected by a lever, one end of which is the bearing for the friction pinion shaft, the other carrying an armature for an electro-magnet at 5, the vibration of the beam, making or breaking the current at 6 for the electro-magnet. When the beam raises, due to additional load, the contact is made, armature attracted, pinion put into gear, and the poise *q* moved forward until the beam descends and the contact is broken; at the same time the contact between the friction pinion and the dial-plate breaks. Thus far, then, we have the machine for recording the amount of stress at which a specimen breaks. There are, however, other points of information about the material tested, which are of just as much or even greater importance for the engineer to know, such as the yielding point,



BABCOCK & WILCOX BOILER AT THE BALDWIN LOCOMOTIVE WORKS.


200000 lbs TESTING MACHINE.
OLSEN'S

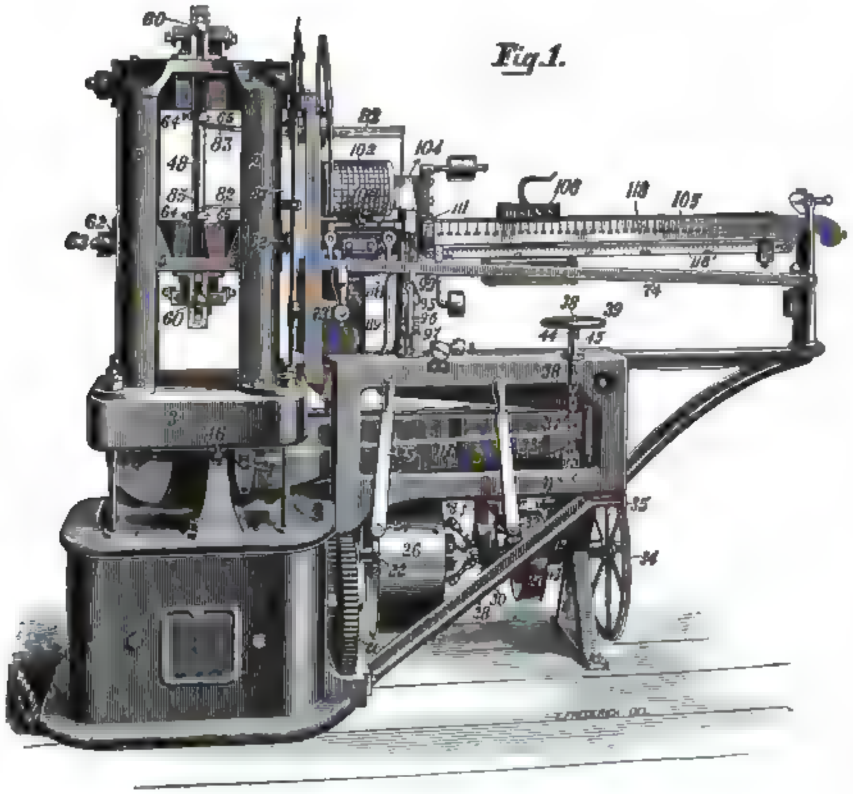


Fig. 1.

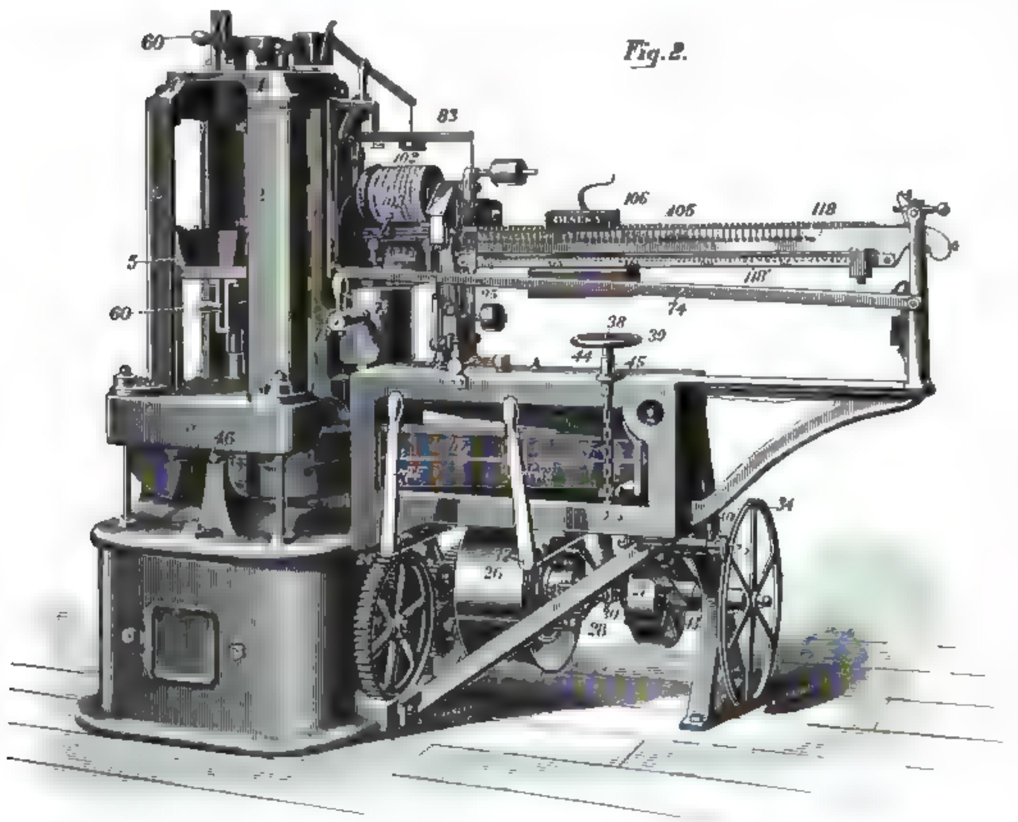


Fig. 2.

and the elongation or the change of dimension of the sample tested. This data, especially the point at which yielding commences, is and has been obtainable in a very crude and unsatisfactory way, and in a great measure has been left entirely to the discretion of the operator, there having been no means for its correct determination for practical use. The drop of the beam, which is used, and is very marked for many soft iron and steel specimens, is for others not so marked, for still other grades and compositions of materials utterly untrustworthy. To make the machine indicate clearly and unmistakably, this point or these points has been my object for many years. About half a dozen different systems for this purpose have been more or less completed but laid aside, not because each system would not work or could not be made to work, and thus in a great measure accomplish the object in view; but mainly because they became too complicated or were too liable to get out of order, or took too much time in its application to be of any practical value. From each attempt, however, some valuable points were gained which finally suggested and helped to develop, not only the best, but the least complicated of them all, and this device seems to be practically all that can be desired for the purpose. It is simple in construction, easy to understand and handle, always ready for use, quick in its application, and not more liable to get out of order than any other part of the machine, as well as of universal use—that is, applicable to the various classes of test.

I will now describe this device. In the illustrations, figs. 1, 2, 3 and 4, the reference marks correspond. On top of the beam is mounted the cylinder or drum 102, which can revolve on its axis; to this drum is attached a sheet of paper, on which the object is to have the mechanism trace a diagram or curve line, which will at the same time show both the stress and the amount of yielding of the specimen.

A pencil at 103 traverses the drum and paper in the direction of its axis; it is moved by the same screw which moves the poise 106, consequently any movement of poise also imparts to the pencil a corresponding amount of motion in the direction of the drum's axis; these distances form the ordinates to the traced curve and represent the stresses.

The other motion necessary to trace the line forming the curve, which will be the abscissæ representing the yielding of the specimen, and is accomplished by revolving the drum corresponding to such yielding.

This yielding motion of the specimen is transmitted to the drum as follows: Starting at the specimen 48, fig. 1, two collars 64 are placed upon it at a certain distance apart, say 8 in., as now generally adopted.

On the under side of the upper collar 64 are fingers 83, one on each side of the specimen, so arranged that they will transmit the central motion of the specimen to the arm 83, arm 83 being pivoted for vertical motion at 88, fig. 4; any vertical motion of the specimen or upper collar is thus transmitted to

point 101, then further communicated by a cord or steel band to one end of the lever 97, which is pivoted at 98. This lever 97 is placed in a vertical plane under the edge of the balancing pivot of the beam.

Starting again at the specimen, on the lower collar 64 is placed another pair of fingers 82, which, in the same manner as the upper fingers, transmit any vertical motion of the specimen to the vertical rod 87, figs. 1, 3 and 4. The lower fingers 82 can be adjusted anywhere along the vertical rod 87, so as to be in proper place for the length of specimen operated upon.

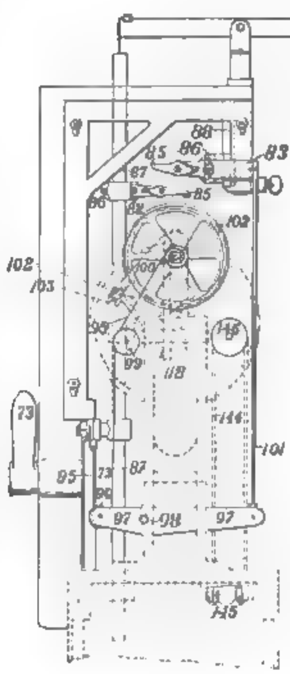


Fig. 3.

The vertical rod is attached by a pivot to one end of the bar 74; the other end is supported on a pivot at 50, and, at a point 99 on this bar in the vertical plane of the balancing pivot of the beam, is attached a band or cord 95, which first runs down and over a pulley 96 in the end of the lever 97, then up and over the guide pulley 99 to the enlarged part of the shaft 100 for the recording drum. Thus the vertical motion of the specimen or the lower collar 64, on the specimen, is communicated to the recording drum, imparting motion to it, or allowing same to turn on its axis.

The function of lever 97, whose one end is connected to the fingers resting against the upper collar on the specimen, and the other end in which is the pulley, to the fingers resting on

the lower collar, is, to separate the motion that takes place by the specimen as a whole, from that motion which takes place in it and only between the collars, or to retain for transmission

to the recording drum, only what may be termed a difference of motion, the motion taking place either in or by the heads of the specimen, not being transmitted to the drum.

The function of lever 52 and counterweight 58, fig. 3, is to balance the whole system of parts, so as to make it sensitive to the smallest variations of motion.

In fig. 5 is shown an arrangement of adjustable heads for parallel specimens, as well as a device for placing these heads on the specimen quickly and in the desired proper position.

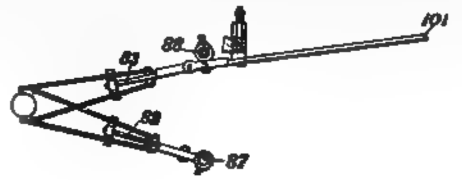


Fig. 4.

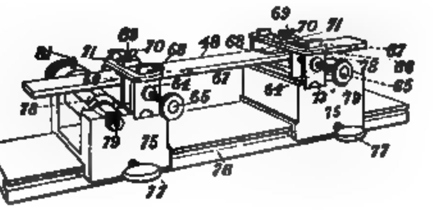


Fig. 5.

The next three figures show this arrangement very plainly, the two at the top being two different kinds of heads, and the lower figure the setting device with the specimen and the heads on the same, ready to be placed in the machine.

Having now shown and described the device and the machine to which it is applied, the next view will show diagrams as traced in the machine. The upper card is of tensile diagrams, No. 1 and 2 of steel shafting, No. 3 of steel boiler plate.

The next card is of tests in compression, as traced on the machine, No. 1 of ash; No. 2 of white oak; No. 3 of hemlock; No. 4, white pine; No. 5, brick; No. 6, a punch diagram, ¾ in. punch through ½ in. steel plate; No. 7, another punch diagram.

The lower card contains diagrams of transverse tests, No. 1 of wrought iron; No. 2, general foundry iron; Nos. 3 and 4 of pig iron.

In this last view given is shown a wire testing machine, just recently designed and finished, in which the graphical system, as before described, is considerably altered and modified. Having for some time had much inquiry for wire-testers that would test quickly, as well as furnish more data of the test than those hitherto in use, this subject was taken up and resulted in a machine as the view represents.

In this design the automatic operation of the beam enables the operator to do more than twice the amount of work performed on previous machines in the same time. In the graphical arrangement, which in this machine you will notice to the right, the diagram paper is placed on an inclined table in front of the operator. The tracing of the pencil in this case, when such quick work is calculated to be done, will be used mostly for notifying the operator when to read the figures on the beam for the yielding point, as well as for quick reading of elongation; as no mark is put upon the wire before it is placed in the machine, the elongation is taken from the card, which is the distance traveled by the pencil in the direction of the abscissæ. The full test covering the yielding point, elongation and ultimate strength can be obtained on this machine in less time than it takes in the older machines simply to arrive at the ultimate strength of the wire.

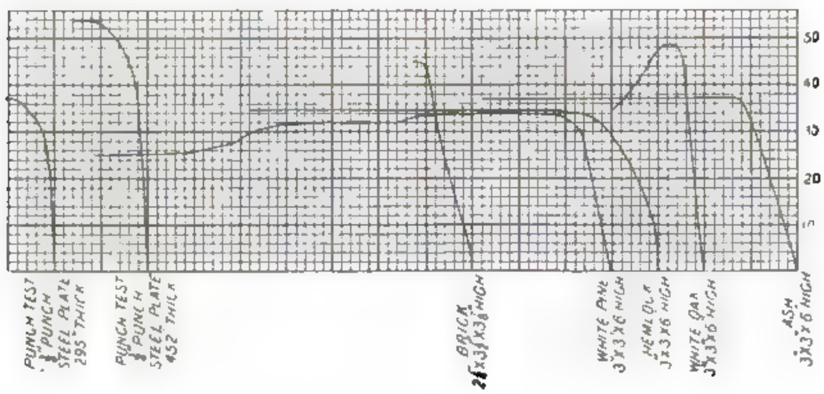
I will not go more at length into the details of this machine, nor into the further extension of the system we are just perfecting, and which promises well for a still greater refinement, which in time it will easily cover—that is, in reference to the line within the elastic limit for tensile and compression tests. The time for preparation was too short, and it would also have taken too much of your time this evening.

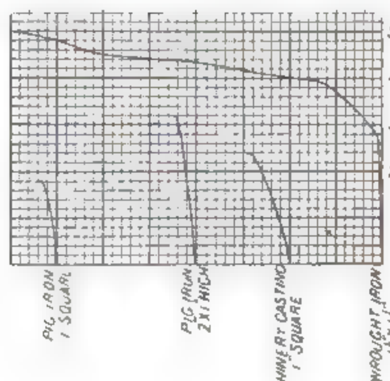
DISCUSSION.

The discussion was opened by the reading of two communications which are here presented, although the first does not relate to the topic of the evening.

FROM D. L. BARNES.

I enclose a diagram which I would like to have discussed; it relates to compression in steam-engines.





The point in dispute is, What is the proper amount of compression in engines having considerable clearance, especially locomotives?

It is almost universally believed by locomotive builders, and to some extent claimed by stationary engine builders, that compression should be carried up to the admission pressure.

Professor J. Burkitt Webb, in a paper before the American Association for the Advancement of Science, has described the proper point of compression to be the point B on the diagram, where the area $A\ B\ C$ is equal to the area $D\ E\ F$. This plan does not take into consideration the loss resulting from the heating up of the metal surrounding the clearance spaces during compression. In some engines the heat that is taken from the compressed steam in this way is considerable, especially in locomotives, where the cylinder-heads are badly insulated.

The diagram with this shows a case of this kind, where the actual compression line $G\ B$ falls below the line of equal steam weight $G\ H$.

It is certainly more economical to heat up the metal surrounding the clearance spaces by steam, taken directly from the steam-chest, than extract work from the momentum of the engine to heat up these surfaces, and therefore in engines where the actual compression line is much below the line $G\ H$, of equal steam weight, the most economical point of compression is below the point B.

In engines having steam jackets, or where the steam chest is placed on the cylinder-head, as in the case of the Westinghouse engine, the actual compression line rises above the curve $G\ H$, and in such engines is not the most economical point of compression above the point B?

FROM E. D. ESTRADA.

As it will be impossible for me to attend the meeting of April 11, when the subject of "Testing Machines and Tests of Materials" will be discussed by the members of the Society, I avail myself of the invitation issued by the Committee, and submit herewith the following remarks, trusting you will kindly read them to the members present.

There is no subject in engineering which has such an extent of unexplored ground as that relating to the resistance of the materials used in engineering construction.

Our present knowledge of the subject is based on the results of experiments devoid of any scientific value, notwithstanding that some text-book authors and experts affirm the contrary.

What scientific value, for instance, can a determination of the "elastic limit" have, when, in the first place, we do not know what it is (see text-books on the resistance of materials), and, in the second place, we have no standard method of determining it?

The lack of a standard method of testing, a standard form of specimen, and a standard unit of measurement, is the cause of much mystery in this branch of our profession.

There are some of you, no doubt, who believe that the ultimate tensile strength of wrought iron and steel is increased by straining the material permanently, and then allowing it to rest.

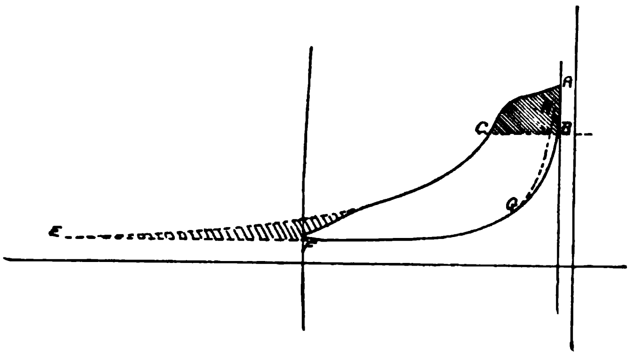
Experiments have been made, and to some minds it has been shown conclusively that such is the case. But let us ask the question, Were the conditions under which the specimens were permanently strained and then allowed to rest the same as those under which they were finally broken? We are left

without an answer. How can we then attribute the increase in ultimate strength to rest?

It is, indeed, lamentable to acknowledge that, if any new steps have been taken for the purpose of determining the physical properties of iron and steel, they have been directed in a new path, leading backward rather than forward.

The time when a test specimen was required to have opposite sides parallel is rapidly passing by, and to-day we find some of our most distinguished inspecting engineers accepting, without a murmur, such tension specimens as are shown in the enclosed sketch.

These are not exceptions; similar ones are tested here every day by the hundreds, and who knows but some of the results thus obtained have gone to form part of experimental data in the establishment of principles.



If a man is foolish enough to accept such specimens, there is no telling how many different conclusions he may draw from the results.

Mr. Gustavus C. Henning: There is always a great question as to what is good boiler steel, and it is very peculiar that when you look at a piece of steel, when it is tested in the machine, you can tell whether it is good boiler steel which will behave well in a boiler, particularly a locomotive boiler, by a very peculiar marking which appears on the test piece. It appears in the form of peculiar striations somewhat similar to double cross-hatchings, and gives the metal a mottled appearance. You will also find a lot of very peculiar marks intersecting at the same angles throughout. Some call that the skeleton of the steel. Of course it is not anything of the sort, but that is a convenient name to give it. When you find that marking in open-hearth steel and the general factors are satisfactory, you can take it for granted that the steel is the best that you can get for boilers. I do not know what is the reason, but many years of experience and investigation of that subject have demonstrated that invariably boilers made from that steel give the best satisfaction. If the specimen is entirely uniform and has no markings of any kind, then the steel is not good for boilers. Then there is another peculiarity in telling whether the steel is really good or not. Say, for instance, you have a flat specimen; if there is a very gradual reduction, then that specimen shows that you have about as good a steel as you can get. If the steel has a shoulder in it, however slight, and then comes down, then there is something wrong with it. But whenever you find that in a test piece, you can say that the steel is undesirable. That is shown by this test piece (showing a specimen).

I also have a piece of a car axle that had been running in service for some time, until finally it broke. On this piece you will see the successive fractures. Most car axles do not break at once, but they break sometimes six months before the axle will be so defective that it will have to be thrown out of service. But each of these rings shows a successive fracture.

Mr. J. Sellers Bancroft: That same appearance is frequently noticed in shafting.

Mr. Henning: Fractures of axles are probably caused more commonly by bad frogs and running over switches than anything else, unless you have a very hard bed lying on a solid rock, and you carry heavy loads over it.

Here is what some people sell for the very best boiler steel, which gives all the ductility and everything else you want, and when you come to look at it, it is nothing but a couple of pieces of wrought iron and steel welded together—that is, they are put in a furnace and piled, just the same as you pile wrought iron plate, and submitted to extra high heat, and then rolled out together. The result is that the material is unreliable, and when you least expect there is trouble with it.

Professor Hutton: Mr. Henning says that a specimen not showing those skeleton marks is undesirable for boilers. In what way does it show afterward in service that it is not a good steel?

Mr. Henning: It will break and crack, and apparently become what they call mushy or honeycombed. It will simply go to pieces if you keep it in long enough. Here is another specimen which is a pretty good illustration of a good fracture, which is the common thing in the better class of steel. There is a theory that says that when material breaks it always breaks on a given plane, and that this angle determines the quality of the material—that is, from this angle you can determine the resistance of the material. Now, in the case of steel, that fracture might be on either side, because it is very good steel, very uniform. The result is that it will not be a sheared surface, but one piece will be a truncated cone and the other piece will be the corresponding cup. I have never seen any practical use made of that theory, that the angle of shear is the characteristic feature from which you can determine the properties of the steel.

I would like to say something about Mr. Olsen's diagramming apparatus. I think these diagrams are really remarkable. I do not think I have ever seen any more correct, or more regular than these, and particularly so in these woods. They are simply beautiful. You see this shows that this wood, which is white pine, is perfectly elastic. Hemlock is by no means elastic, and it is not a desirable wood for building purposes, because it is so irregular, the fibers are not parallel, and some of the fibers may break before others; but in the case of oak you will notice how very straight the line is. There are some irregularities which I think must be due to some temporary derangement. When you get to the extreme test of that wood it becomes suddenly very weak, while in the case of white pine there is nothing of the sort. You have a gradual sliding of the fibers. Then in this case of ash you see a very decided break and a very good elastic line. Of course it is stronger than white pine, but you will notice that its line is more nearly vertical, and that, of course, is a very important feature in the quality of the material.

In the case of these steel specimens, they are also very fine. The steel boiler plate shows the very thing that Mr. Estrada said we do not know anything about. There is a straight line up to that point. Unfortunately this diagramming apparatus, as well as all of the others, does not magnify the elastic curve sufficiently. All the properties for which we use materials are defined in this particular, and if this line were drawn to such a scale as to magnify this distance a thousand times instead of five times, as it is here, then the width of this pencil mark would, on this diagram, be at least 4 in., and you could draw as many lines and different lines in that, running from this point to the extreme corner, as you could draw pencil marks in these 4 in. I pointed that out in a paper which I presented to the San Francisco meeting, and I drew one of these curves on a tenfold scale, and on a different sheet I drew one with a thousand-fold magnification, showing that all the possible errors of observation would be covered by the finest pencil line you could draw, while all the distinguishing characteristics of treating steel by different methods are entirely covered by this thickness of pencil line, and this curve would show nothing, while if the magnification were a thousand times, every different method of treatment of steel, whether you heat it or cool it, or heat it suddenly or cool it suddenly, or heat it uniformly to a certain temperature or a higher temperature, would be indicated by the different shape of this line, whether it be more nearly straight or less so, and especially where the elastic limit is located. Mr. Estrada said you could not well define the elastic limit; but up there you will notice just at the top of that shade where the line deflects, that is the elastic limit, and where it shoots over to the left, that is the yield point. Where the proportionality of extension changes, that is the elastic limit, and where the proportionality ceases and there is a continued stretch without any appreciable increment of loading, that is the yield point. Those points are very well defined, and nothing will characterize those points in material as well as a diagram. Then, on the other end of these curves you will see that there is the maximum load, and then beyond that the testing machine is sufficiently good to let the weight run back until the specimen breaks at a load very much less than that carried before; especially in the case of this steel casting here. That, Mr. Olsen says, was cold rolled, showing how cold rolling affects the properties of the steel. The testing machine allows the weight to run back on the beam, which is very prettily shown there, and the specimen breaks at a much lower load than it carried before. On the other hand, you will notice that we have no indication there that the two pieces of steel have been treated any differently; while if that elastic line were drawn with a thousand-fold magnification, it would show a

very marked change from what you see on the diagram there, and would really be characteristic of the treatment to which the material had been subjected. I hope that the diagramming apparatus will be so worked out that we will get one that will draw nothing but the elastic curve, and this on a very much magnified scale, when we can simply have a diagram of that sort, and from the mere appearance of that diagram determine what treatment the material had been subjected to. Of course I do not mean to say that a diagram, except in very rare cases, can be used to measure off elongations or loads unless you have made all possible corrections for errors of instrument, and temperature, and what not; but at least the shape of the curve would be undoubtedly of most valuable assistance in determining the particular influence of the treatment to which the material may have been subjected.

Mr. J. Sellers Bancroft: I might say that we have been working on a recording apparatus to meet this thing which Mr. Henning speaks of. We have made a number of experiments, and it looks as though we should succeed in accomplishing something; but we have not got it ready to talk about it. We have it magnified on a scale of a little over a thousand times. I believe that diagrams before the yield point is the point we have to look to.

Mr. Henning: In regard to the diagramming apparatus, I would say that the prettiest thing I have ever seen is a photographic apparatus designed and used by Professor Marten, of Berlin. He simply throws a ray of light from a little mirror on a sensitized film. The room is dark except for that ray of light, and having the mirror move in one direction by the motion of the weight, the position of which determines the load on the specimen, and the revolution of this very small mirror throwing the beam of light across the sensitized film, draws, photographically, diagrams just like these, and he can magnify them as much as he likes, because it is only a question of casting the ray of light through a lens on a more or less distant screen. Afterward he develops them, and he has obtained some very beautiful results. Another thing he does is rather unique. He makes a diagram of these minute extensions. These extensions within elastic limit are less than .01 of an inch actual measurement. He has a little apparatus consisting of a movable glass weight, and the specimen moves a diamond point. That diamond point engraves a fine line on the glass, and it is so small that the head of a pin will more than cover the whole diagram. Then he puts that in his lens and projects it on a screen. When thrown on a screen and compared with the observations of other instruments the results are comparable; but it is remarkable how you can make a microscopic picture like this and throw it on a screen and check up your results. Of course he did not intend to check up his results by that diagram, but the diagram was sufficiently good to do it. He uses that only when he tests small objects, such as paper or silks. He has not used it for structural purposes. I would like to pass this around and then call attention to what it is. This is a 2-in. specimen; this is an 8-in. specimen; that a 6-in. specimen; that a 4-in. specimen. It is always a question how much does that material extend. If material is uniform, the extension should be the same. Take the elongation as measured between the unloaded condition of the test piece and the maximum load, and you will find that the percentage of elongation up to that point is always uniform, whether you test a piece 2 ft., 10 ft., or 20 ft. It is quite independent of the shoulders or length of the specimen or anything. This point indicates that a test piece which was reducing perfectly uniform is endeavoring to neck down or have a reduction, as they call it, and finally the fracture generally occurs in there (indicating) just as that little circular piece shows. We generally measure the elongation by taking it between two marks that I made here, and including local elongation in that, and after having observed that—of course, that is observed after you take the test piece out of the machine—then if, by calculation, shown in Report No. 4 of the Society's Committee, you deduct the total elongation from the local elongation, you will get the percentage of elongation. It is very difficult to work out the exact proportionality. In that 2-in. test piece we may have 50 per cent. elongation, because the 2 in. in here elongate vastly more than the rest; but the length of the specimen has a great influence on the recorded percentage of elongation. That, of course, vitiates statements of elongation of material, unless you are told on how long a specimen the elongation was measured. But these photographs are photographs of pieces that were tested that way, and in every case the proportional elongation is identical, whether the piece is 2 in., 4 in., 6 in., 8 in., 10 in., or anything. The elongation in this case runs from 22 per cent. up to 43.7 per cent., while when you take a correct observation, the actual elongation of that material is a little over 25 per cent. in every case.

Mr. Brinckerhoff: I would like to ask if the cross-hatched appearance on the faulty steel is supposed to be due to the same cause as the cup on the round steel.

Mr. Henning: I do not think it is anything like it at all. This is something that never has been determined, and we cannot find out at all why. That skeleton has been cut out and analyzed chemically, and you cannot find any difference between that and the remaining material. We simply know from thousands and thousands of tests that have been made in the same way that the material that shows marking is always the best material for boilers, and that when the material does not show it it is not good for boilers.

Mr. M. N. Forney: In this connection I will call attention to what has been observed in the punching of fire-box plates for locomotives. Mr. William S. Hudson, formerly the Superintendent of the Rogers Locomotive Works, first called attention to it. I will exaggerate it somewhat, so that the members can see it (referring to a sketch). In punching the holes for the stay-bolts in locomotive fire-box plates, Mr. Hudson observed markings somewhat of that shape—curved lines which radiate from the hole all the way round. Now, the curious fact was that there was another series of rings which radiated in the reverse direction. It is very much like the milling work on a watch-case. I never heard that any relation was observed between the quality of the steel and those markings. I think that all the conclusion Mr. Hudson came to was simply like the old lady's theory about indigo. When she put it in water, it would sink if it was good, or it would sink if it was bad—she didn't know which.

Mr. Henning: When you drop a plate on edge on a heavy body you will get them. They are simply lines of intersection of stress. If you hit a plate with a hammer you will get those marks. The stress, of course, radiates from this point. There are lines of pressure outward in every direction, and, of course, there are resisting lines in the other direction. When you plot all these curves and all these lines of stress, and the diagonals of these lines of stress between the resistance of the material and the lines of stress, you will find intersection of these lines, and when you make a sufficient number of them you will find that you will get these curves. They are nothing but the intersection. Instead of having one intersection, suppose you take a number and through all these you pass other lines, the scale will not break except at the intersection of these two lines of force, because there the material is displaced locally, and the scale will crack off there and leave these wide lines which simply indicate the intersections of the lines of stress. You will find it in every case when you strike a piece of steel, so long as you strike it hard enough to break the scale.

Professor De Volsen Wood: I may be pardoned for saying, in regard to these lines that have been indicated by Mr. Henning as lines of stress, that Rankine, when he diagrammed them, called them lines of shear. They were shearing stresses, and they were conjugate at that; but I was wondering why those were curves in the case of punch plates, and I have not satisfied myself theoretically why they should be curved. It is a good thing to have the fact independent of the theory. I once had a conversation with Mr. Lavan, a celebrated Canadian ventilator of buildings, and I told him that I had tried his system in my private house. I let the air in at the top and made a place for it to go out at the base on the opposite side, and the air would go right across instead of diffusing itself into the room. "Professor," he said, "it is contrary to theory." He had the theory and I had the fact. So I am pleased to get the fact in regard to this curve.

Mr. Bancroft: We made some diagrams some years ago of the force required to punch, which resulted in a rather different diagram from that shown by Mr. Olsen, simply because the material, I suppose, was very much thicker relatively to the diameter of the punch. The thickness of the plate was very nearly equal to the diameter of the hole, and the pressure ran up very rapidly—reached a maximum when the metal was starting, then it fell off to about five-eighths of the total height, there being a perceptible amount of pressure required up to the very last moment. A flat punch was used.

Mr. Henning: You can reproduce similar lines by simply vibrating a plate and throwing sand on it. If you take the proper plate and the proper force you can arrange lines almost identical with these. If you take a plate of glass with a hole through the center and make the plate vibrate, I think you will get those identical lines in fine sand. I think you can reproduce those lines exactly by means of a plate of glass, showing that in circular lines where the stresses intersect you will get an effect, and where the stresses do not intersect you will get no effect. Where the glass plate remains quiet the sand will gather; where the glass plate has any motion there will be no sand. When the lines of force intersect, they will neu-

tralize one another and the sand will remain there, but where the glass is all in vibration there will be no sand.

You can find these curves for a great thickness in the metal. I do not know how deep they go. I should judge they would go all the way through, just the same as when you take a die and stamp a plate of steel with it, or when you cast a name on cast iron and take it off. If you put some acid on it that whole name will come out perfectly plain. If you take that same material and polish it and do everything you can, the mark will still be there and that can be found a quarter of an inch deep. If you mark a letter on a steel plate where you have uniform material, you can try to remove that, and no matter how much you try, it will always come out again, especially if you use a little acid and etch it. I know that people have taken other people's patterns and taken castings off them, and they would simply chip off the names, and afterward, if you want to find if that casting had been made from such pattern, all you have to do is to polish that up and etch it a little bit, and the whole name will come out as plain as if you had painted the name on.

MR. MITCHELL: I would like to ask regarding the speed at which a testing machine should run. I talked with one or two members of the Association before the meeting, and I could not get any light on the subject. It is a fact that you can get different results according to the different speeds at which you run a machine. If a plate is tested on a certain machine, it will give us results like the specification; if tested on another machine at different speeds, we will get different results. We will accept the material on the test given on one machine, and on the other we will condemn it. I refer to the speed at which the piece is tested. The higher the speed, the better the tensile strain. I was educated on a Riehle machine designed by Mr. Olsen. It was the first machine the Pennsylvania Railroad had, and I worked that machine for 14 months. I tested over 9,000 samples. The speed was 1 in. in three minutes, and that is the speed at which I always tried to run the machine. I have, however, never tested the same machine at different speeds.

MR. HENNING: If you test soft steel, especially basic steel, it does not make any difference what speed you test it within your capacity of observing anything about the test. Of course it is well known that in the Carnegie Works they test so fast that you simply take the man's word for it that it carried that much; but if you know your business you do not let them run a machine rapidly. There is a reason why the machine should show higher results when run very fast, and that is so much momentum is applied through the test piece to the beam, which is of considerable mass, that it will always keep carrying more. When you come to a rest the machine balances all right. But as you keep on running the weight is always ahead of the load you have on the test piece, and the faster you run the further the weight will be ahead of the load, in order to counteract the momentum due to the increase of the force applied. If you apply the same force, the momentum in the beam will be the same. There is always an increase of force applied. Hence, there is always an increase of momentum, which must always be counterbalanced by a slightly advanced position of the weight. But if you run as fast as 2 in. in one minute, on the ordinary soft steels, you will not find any difference. When you test boiler steels which have different qualities altogether from the soft steels, there you find considerable difference. There is a difference between the acid and the basic steels. The acid steel always has more carbon than the basic. You can run the Emery machine as fast as you please. Of course it takes the greatest skill to keep the Emery indicator floating between the marks; but so long as that indicator floats between the marks, you have always got the indicated load on the piece. If the machine is running so fast that you cannot observe every point about it, it is going too fast. I simply see how the machine behaves, and if it behaves well, I let them run a little faster. When the machine is a doubtful one I run very slowly, until I find out what the machine is. When I want to know what results I get out of a machine, I calibrate the machine. If you do not do that you do not know what the material stood.

PROFESSOR HUTTON: I think there is more in that subject that Mr. Mitchell has opened than Mr. Henning fully covers, while his explanation is of real value. I remember a case which came under my own observation not long since, where a firm in town here wanted to send some copper for fire-boxes to the Baldwin Locomotive Works, who were going to send some furnaces to South America, where they have a fondness for copper. They wanted some unprejudiced party to say what the copper would do. The requirement was stretch, 25 per cent., and tensile strength, 35,000 lbs. They asked me what kind of sample I wanted to test. I said, Give me at least 4 in. of reduced section taken from the ½ in. plate. We were running at that time on the old Fairbanks screw machine, and I found it impossible to give that 35,000 lbs., but I could give them 35 per cent. to 40 per cent. stretch right along, but we could not raise the tensile strength higher than 33,000 lbs. I finally told these gentlemen that I thought the Fairbanks machine was not the one to test this piece on, because those people down there are used to a hydraulic machine. So they took the specimen down to the Post Office and got Mr. Starbuck to test it, and got the test all right. I could not absolutely get it in any way on the old Fairbanks machine. The specifications were based on a hydraulic machine. There is something in the material itself and in the fact that if you will put a load on past the elastic limit, you can leave the load of the elastic limit of a material like copper and simply pull it out, and simply by putting on a little additional strain every day, the thing will ultimately break. There is something, I am sure, in the speed besides this mere inertia of the beam, which of course does enter as a problem when two tests are made at nearly the same speed; but where there is a great difference in the speed I think the material comes in.

MR. HENNING: What I said applies only to steels. Professor Hutton is perfectly right, when you apply it to certain grades of steel, as manganese steel, or to Tobin bronze, or copper. The shape of the test piece also has proportionally greater influence on the results obtained than the treatments to which the material might have been subjected, in order to have produced certain results; but in the case of alloys and coppers, you have to be very careful about using the proper speed, and giving the material time to arrange itself. Of course that higher tensile strength is only fictitious. That is an artificial advantage which you would not find in service in a boiler. They would simply break at a lower load, if the load ever got to that point.

I heard from a gentleman in Pittsburgh to-day, who wanted to come here to speak on this very subject, but who did not get his invitation in time to be present, and he asked me to refer to it if no one else did. If you test material immediately after it comes from the rolls, the material will be decidedly weaker than if you keep it lying idle from 12 to 24 hours. Our better rolling mills never give you a piece, especially thin shapes of plate or small bars, that have not had a chance to recover after being rolled. If you take a sample from a plate as it comes from the roll it will not give the ultimate strength, nor will it show the elastic limit or elongation within a very considerable amount. So it is often a question of rejection or acceptance, whether you allow the material to rest awhile before you test it or whether you test it fresh from the rolls. About the benefit of giving the material rest after having done work, I do not think that ought to come into account with engineers, for the reason that we are not supposed to use material that way. It is a well-known fact that when you strain material and then let it stand, instead of giving you the normal curve, you find it varying at a point lower down; but at the point where the rate of proportionality of elongation changes, would probably have been changed slightly after starting up again, and then the yield point would have been augmented. Now, if you carry this on several times you would always get a little offset with a little higher elastic limit. It would remain there afterward, but you see you have hurt material. You never use the material in structural work, except below the elastic limit. When you take material that has an elastic limit of 30,000 lbs. and load it to 15,000 lbs., you are exceeding the working load you are allowed to put on material. In testing material and taking a diagram to this point and stopping here, the material will stretch a little bit if it is soft material. Just as soon as you begin again to reload the test piece, a line, parallel to this extension line, will be produced and the resistance of the material is increased until you rise above the maximum, and you can increase it so that ultimately it will not break off at the normal point, but it will break off far short of it; hence, though I have not got enough data to prove it, I think you will find that when you get the whole area in the modified diagram, it will be less than the original area that you would have obtained if you took it within the natural curve, showing that the material, although it shows a higher load or a higher elastic limit, is inferior. Of course the main point is to determine the material in the conditions in which you intend to use it.

PROFESSOR WOOD: I have seen tests made under the conditions now referred to, where the piece was partly broken, and then, when allowed to rest, either with the stress on or with it removed, when the stress was renewed the elastic limit was raised, as Mr. Henning has said, that it becomes less durable. The elastic limit may be raised in that way, and the failing point also raised. I acknowledge that this fact was an interesting one to me, if not a profitable one by way of instruction. Before this was known I felt fearful of

the hydraulic method of testing boilers, that by applying a stress larger than that which it was intended to carry, the material might actually be injured; but after this discovery was made I saw it was a good thing. The material was not injured. It would stand a stress from steam without failure greater than it would if the steam pressure had been applied the first time without that stress, and although the material should not, as Mr. Henning has said, be used to any such an extent, yet it is sometimes, under exceptional conditions. In the case of steam, the pressure does sometimes run up much beyond what was intended. However, whether it be so or not, we cannot study the properties of materials too carefully and learn what results from all kinds of stresses both within and beyond the elastic limit. I was not displeased to hear, as I came into the room, some remark in regard to our not knowing anything about the elastic limit. It reminded me of a remark made to myself by an engineer. He said, "You talk about the factor of safety. The factor of safety in these days of science and knowledge! I call it the factor of ignorance." That just covered it exactly. I did not care for the term, but it was a correct one, and he would have us understand that we ought to determine exactly the conditions of things in regard to the materials used in construction. We do know, from long observation and experience, that there is a general, if not a very specific relation, between the so-called elastic limit and the ultimate strength. If the strength is 60,000 lbs., the elastic limit may be nearly 30,000 lbs., so that we have a factor of one-half for the first one, and as an approximation toward what we may use; but there comes in our ignorance. We do not know exactly where the elastic limit is, and, as already stated, the ultimate strength depends on the manner in which the piece is broken. That only shows us that as experiments go on, and as our knowledge becomes more and more definite, that the manner of breaking a piece becomes an important element. Some students of mine were about to test a piece that was an annulus—a pipe only. They drilled the hole out of solid iron, and after they broke it they brought it to me. I did not see anything peculiar about it, until they called my attention to the fact that at a certain place there had been no yield or no apparent stretch, and they said the drill broke when they got to about a third or less than one-half the length. To get out the broken piece they struck with a hammer on the side of the piece to jar it out. Now, where they struck with a hammer—not very heavy blows—all around the outside of the cylinder, it apparently did not yield at all. The stretch was outside of that. There was an object-lesson at once, which teaches us that every change that is made before or during a test affects the result. I am not surprised, for I have long known the fact that the rate of testing a piece—that is, the rate at which you break it, has an effect on the measured strength. It should; and so with regard to the composition, the manner in which it is manufactured, so in regard to the manner in which it is cut out, so in regard to the length of the piece, whether it has a shoulder or not. All these elements will affect the results, so that the only true method, it seems to me, of getting comparative results that are valuable, is to have them made under similar circumstances, and that the rate at which the piece is broken shall be an element in the test.

Mr. Mitchell: The worst strains we get are on the side rods of locomotives. There we use a very large factor of safety; it being about 12. We figure the centrifugal strain and that due to the piston, considering that the large factor of safety which we use covers all strains. We had one engine running about 40 miles an hour which broke both side rods. She slipped and we used sand, and she caught in the sand and another rod broke. I figured the factor of safety of those rods as nearly as I could, and I found it was only 4½. I built the rods much deeper, and we have not had any break since. I use a factor of safety of 12 with Otis steel.

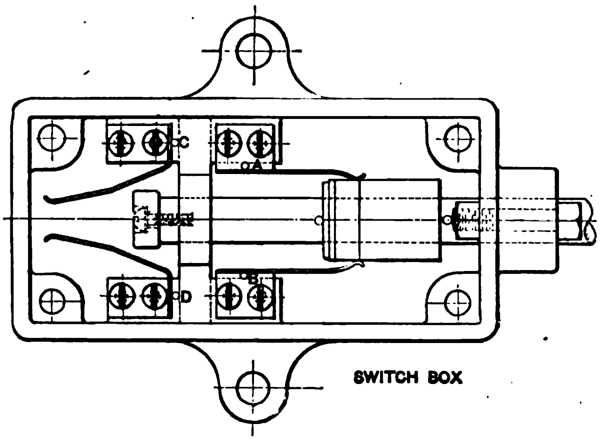
Dr. Emery: On that subject there is an interesting contribution in the transaction of the American Society of Civil Engineers. Mr. William Metcalf, himself a steel manufacturer, had occasion to make a machine in which two axles were to be connected, and he used two side rods like those of a locomotive, and run at much higher speed than a locomotive. Using steel that was soft, they broke very rapidly. It occurred to him that it would be a good thing to make them stiffer, and he put in some steel having .07 or .08 per cent. of carbon, and they would run so many years.

Mr. Mitchell: I claim that a rod, if properly designed, on an engine, using that factor of safety of 12, will last as long as an engine, and that is 25 or 20 years.

The Chairman: I have here a letter from Mr. McFarland. It has been proposed to have the subject of the next meeting Marine Tubular Boilers, and Mr. McFarland, Past Assistant Engineer of the United States Navy, is expected to start the talk.

THE KINSMAN BLOCK SYSTEM.

The Kinsman system of block signaling, as exploited by the Kinsman Block Signal Company, of 143 Liberty Street, New York, includes a cab signal with an automatic closing of the throttle-valve and application of the air brakes. It is an ingenious mechanism for avoiding the disastrous results which may arise from heedlessness on the part of the engineer or the invisibility of the signals beside the track. Besides being ingenious the system possesses the further merit of simplicity. Of course, electricity enters into the mechanism and occupies a prominent place in its operation. The fundamental idea of the device is that if a train is occupying a given block, or a switch is open therein, another train will be prevented from entering by the automatic closing of the throttle-valve on the engine and the application of the air-brakes.



SWITCH BOX

Before describing the cab mechanisms by which this result is obtained, we will look into the wiring and electrical devices that are used. Track circuits are employed. A primary battery has its two poles attached to the two rails, which are laid in insulated sections, each wire running to its rail direct as well as through a relay. When the track is clear this current passes uninterruptedly from the battery through the relay, and the armature of the latter is held against the magnets. Let a train enter the section, however, and straightway the wheels short circuit the current of this battery, the relay is cut out, and the armature drops upon its stops. In doing so it makes a connection by way of a local battery between two guard rails (contact rails they are called) insulated from each other and the main line, and placed at a suitable distance ahead of the protected section. In this condition no current is passing through the relay, and the circuit of the local battery is not completed. Should an engine pass these contact rails, the brushes with which it is equipped rub against them and complete the circuit of the local battery; this excites an electro magnet in the cab, raising its armature and causing the work already indicated to be done.

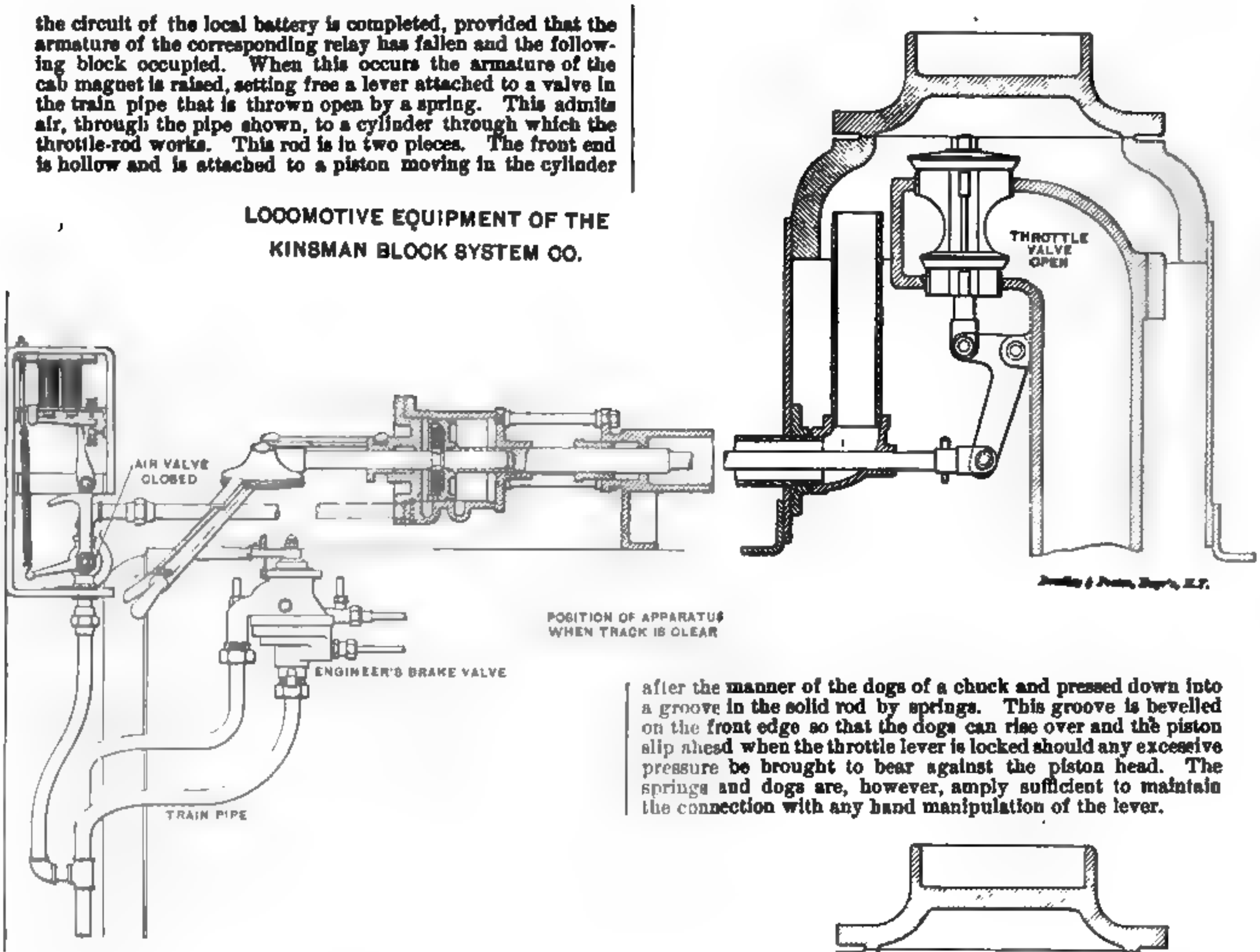
Switches are protected in a similar manner. Thus the two rails of a switch are connected to a relay set like the block section relay and operating in the same way. One wire passes through a contact point in a box attached to the switch-rod. This box is so constructed that when the switch is shut the current passes through the box and on to the relay; but when the contact is broken the current is not only interrupted, but, as a further precaution, it is short circuited by means of another contact point in order that every possibility of exciting the relay may be avoided. It will be seen by reference to our engraving that this box is of an exceedingly simple construction. It is rectangular, and contains a rod moving freely to and fro as the switch is operated. This rod has two hubs, each provided with a brass ring, one for making contact with the relay wire and the other for the short circuiting connections.

It will be seen, too, that should any accident happen to the main battery so that it becomes inoperative, the relay is demagnetized and the block closed.

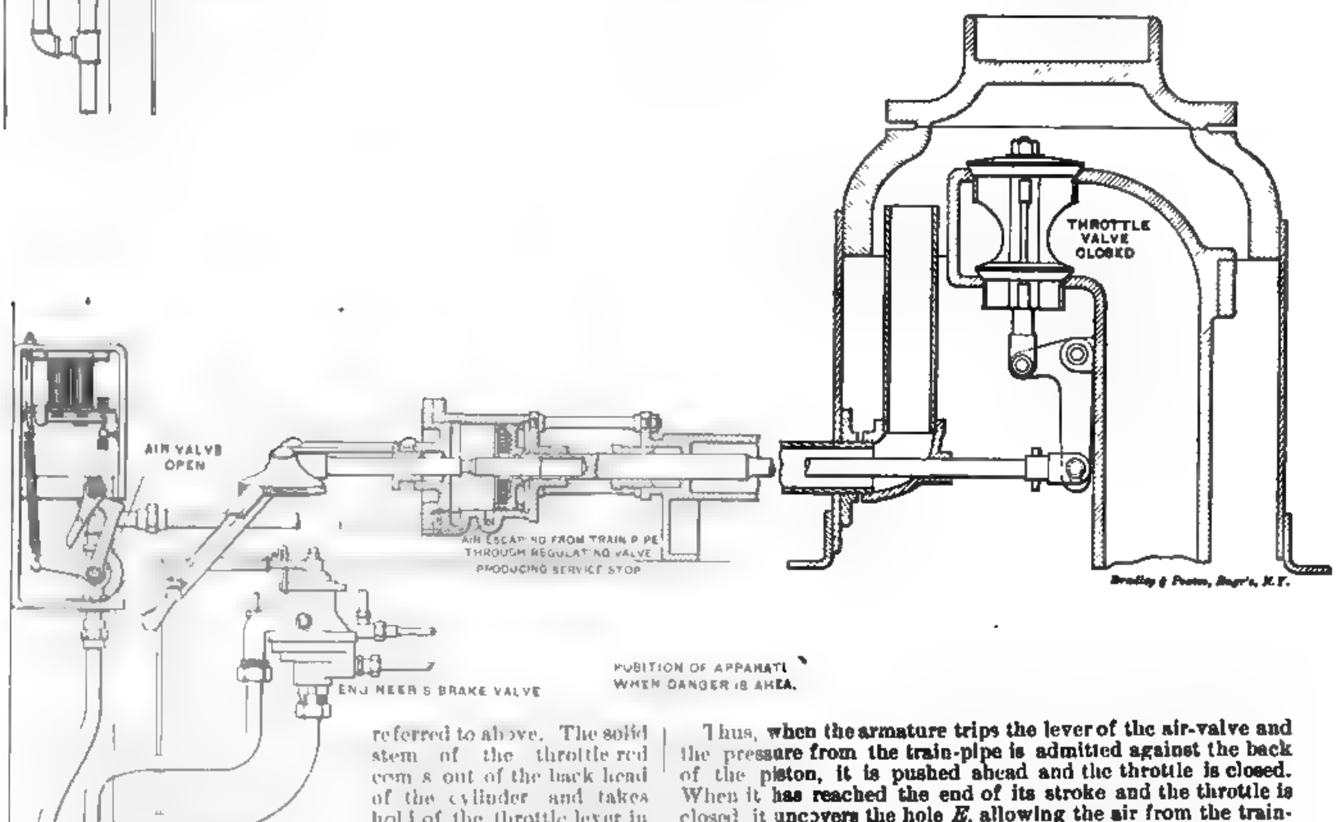
Coming now to the car mechanisms, our engravings show the apparatus in the free running and the automatically shut-off positions, the latter with the brakes set. There is no battery in the cab. The wires leading from the electro magnet shown run down to two contact brushes that are insulated from each other and fastened to the front truck. When these brushes strike the contact rails already described,

the circuit of the local battery is completed, provided that the armature of the corresponding relay has fallen and the following block occupied. When this occurs the armature of the cab magnet is raised, setting free a lever attached to a valve in the train pipe that is thrown open by a spring. This admits air, through the pipe shown, to a cylinder through which the throttle-rod works. This rod is in two pieces. The front end is hollow and is attached to a piston moving in the cylinder

LOCOMOTIVE EQUIPMENT OF THE KINSMAN BLOCK SYSTEM CO.



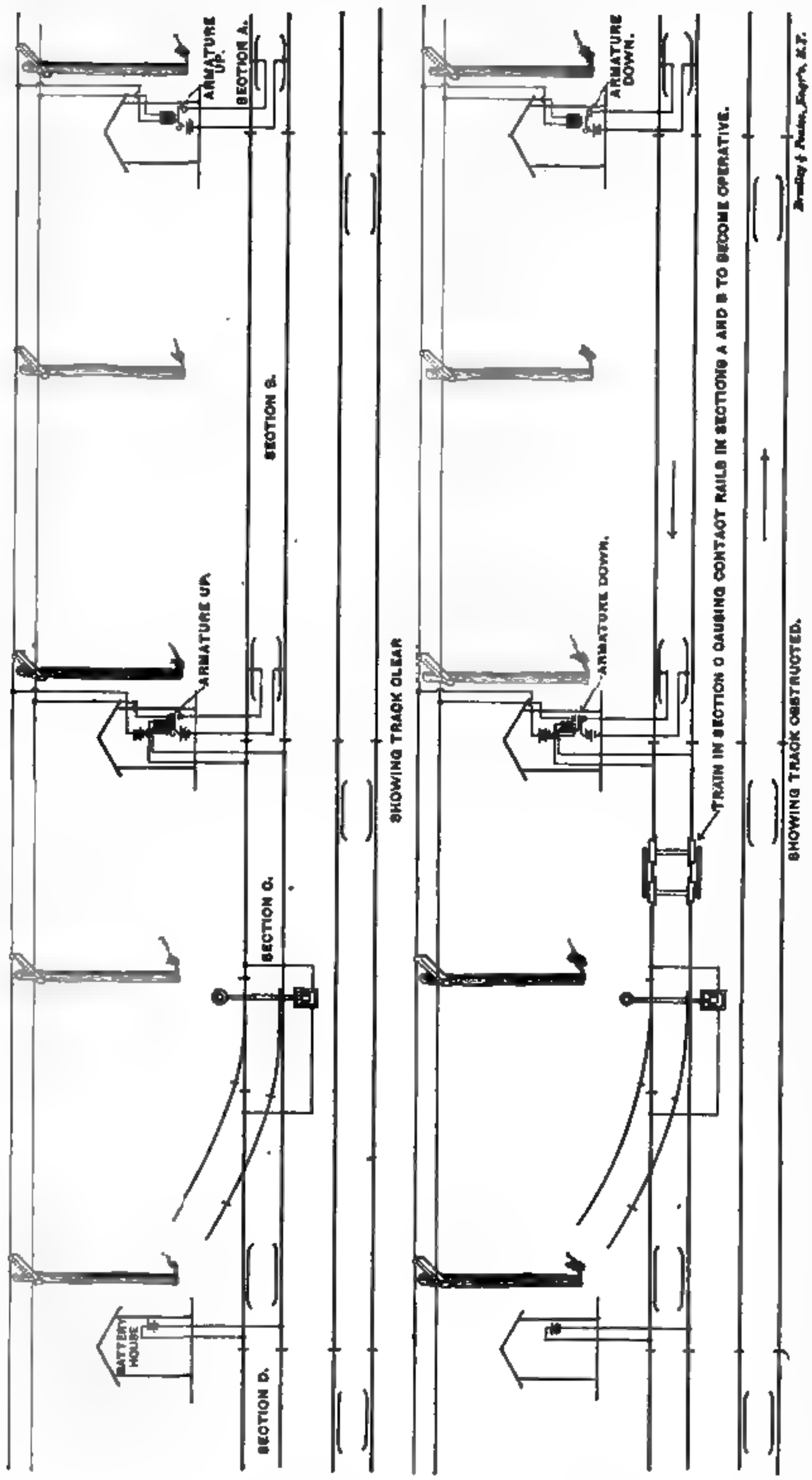
after the manner of the dogs of a chuck and pressed down into a groove in the solid rod by springs. This groove is bevelled on the front edge so that the dogs can rise over and the piston slip ahead when the throttle lever is locked should any excessive pressure be brought to bear against the piston head. The springs and dogs are, however, amply sufficient to maintain the connection with any hand manipulation of the lever.



referred to above. The solid stem of the throttle rod comes out of the back head of the cylinder and takes hold of the throttle lever in the ordinary way, no change of construction being made in the battery. The connection between the solid and hollow portions of the rod is made by means of four dogs set in the piston-head

Thus, when the armature trips the lever of the air-valve and the pressure from the train-pipe is admitted against the back of the piston, it is pushed ahead and the throttle is closed. When it has reached the end of its stroke and the throttle is closed, it uncovers the hole *E*, allowing the air from the train-pipe to escape and making an emergency application of the brakes. Thus there is no change in the cab mechanisms. The throttle lever remains in the wide open position and the handle of the engineer's valve is in the running position. The engineer recovers possession of this throttle-valve by merely pushing his lever ahead until the dogs engage in the notch, and his brakes are at once readjusted to the usual working condi-

tions by the raising of the air-valve lever until it again rests against the armature of the relay. The engine is then ready for another stop, nothing has been disarranged and nothing has been broken.



ARRANGEMENT OF CIRCUITS OF THE KINSMAN BLOCK SYSTEM CO.

STEAM LIFEBOATS.

That the efficient mechanical propulsion of a boat to be used for life-saving purposes has for a long time been a problem surrounded with apparently insuperable difficulties is evidenced by the fact that up to within the last three years but one of the few proposed solutions of it can be said to have met successfully the requirements of such a vessel. Propulsion by paddle-wheel was, as a matter of course, out of the question, and the application of the screw propeller had so many drawbacks in view of the conditions under which lifeboat service had to be performed, that the matter resolved itself into some efficient application of water pressure to give the requisite propulsive power.

In May, 1891, it was noticed in the *Times* that the Royal National Lifeboat Institution had in the previous September placed on trial at Harwich the first mechanically propelled boat intended for life-saving purposes. This vessel, named the *Duke of Northumberland*, was constructed by Messrs. R. & H. Green, the widely known shipbuilders of Blackwall, and engined by Messrs. Thorneycroft, of Chiswick. She is 50 ft. long, 12 ft. beam, and her loaded displacement at 3 ft. 6 in. in draft is 28 tons. Her propelling machinery consists of a horizontal compound surface-condensing engine of about 170 H.P., driving a nearly horizontal turbine of 30 in. in diameter, which delivers its water through two outlets in the sides of the boat, and draws its supply through a vertical scoop-shaped inlet amidships. The boiler is one of Mr. Thorneycroft's patent water-tube type, with a heating surface of 606 sq. ft., and grate surface of 8½ sq. ft. This boat, after going through an exhaustive series of trials, making during one of them the passage from Harwich to Holyhead, a distance of 1,000 miles, without the least mishap, was eventually placed on the station at Harwich, and has since done excellent service in the saving of many lives and much valuable property.

Owing to the success attained with this first attempt in the construction of a really serviceable mechanically propelled life-boat, Messrs. Green were instructed with orders to build two new boats for a similar purpose, one for the Royal National Lifeboat Institution, and the other for the Lifeboat Institution of South Holland. These vessels have the following principal dimensions: Length, 53 ft.; beam, 16 ft.; depth, 5¼ ft.; and their loaded displacement is 30 tons, giving them a draft of 3 ft. 3 in., at which they will carry from 30 to 40 passengers, four tons of coal in the bunkers, and half a ton of fresh water in their reserve tanks.

The experience gained at and since the trials of their first vessel of the type has enabled her builders to make material improvements in the two now nearing completion. The first of them—or that intended for the Royal National Lifeboat Institution—launched some months ago, is nearly ready for her official trial; the second—that for the kindred institution in South Holland—was launched recently, and named by Miss Ella Green, daughter of one of the partners of the firm of builders, the *President Van Heel*. As these vessels are sister boats, the improvements effected in construction and machinery apply to both.

Instead of propulsion being dependent, as in the case of the *Duke of Northumberland*, upon one turbine and inlet to feed it, the new vessel is fitted with two vertical centrifugal pumps placed on the starboard and port sides, driven direct from the crank-shaft—to which they are coupled and co-axial—of an inclined compound direct-action engine of 200 H.P. For forward and backward motion, go-ahead and go-astern, outlets—the former in the bottom and the latter in the sides of the vessel—are connected by pipes to each of the pumps, and to give a lateral propulsion to the boat a special side outlet has been arranged—which has been patented by Mr. J. F. Green both in England and abroad—the advantage of which when

manœuvring round a wreck is considered invaluable, as the water can be discharged through the outlet nearest the wreck and thus act as a buffer or fender in keeping the boat and the wreck from colliding, and assisting it by sideways propulsion in getting clear away when desirable. The buoyancy of the new vessel has been very carefully considered, and to add to her safety she is divided into no less than 18 water-tight compartments; but should one of these be stove in, provision is made to connect it with the centrifugal pump inlets in such a way that the inflow of water would be utilized for the boat's propulsion. The boiler for supplying steam to the compound engine of the vessel is of the water-tube type, and will, together with the whole of the propelling machinery, be fitted by Messrs. John Penn & Sons, of Greenwich. It is expected that the official trial of the first of the improved type of steam lifeboats will shortly take place.—*London Times.*

THE ADAMS UPRIGHT WATER-TUBE BOILERS.

We illustrate a boiler made by the Adams Water-Tube Boiler Company, of Cleveland, O., that presents some novel features in the construction of this class of boiler. The great difficulty that has heretofore been experienced with water-tube boilers that might be called of the porcupine type has been that the amount of sediment and scale deposited in the tubes has been so extensive as to cause them to burn out very rapidly, as well as the fact that the arrangement of the tubes and the conditions under which they were worked rendered circulation almost impossible.

The boiler under consideration is so designed that it is evident that there must be a continuous circulation, and at the same time the sediment held in solution by the water is deposited in such portions of the boiler as to be readily cleaned, and not in localities where it will burn to the surface. The vertical section shows that the boiler consists of a vertical column filled nearly to the top with water, from which tubes radiate into the fire spaces. The lower portion of the boiler has a mud drum, which is below the grates and is not affected in any way by the intense heating of the fire.

At the top of the boiler, and just beneath the steam space, there is a basin into which the feed-water is projected. This basin is kept nearly filled, and the water in it is heated to the temperature of the steam; but inasmuch as it is only subjected to the heat of the gases in the upper portions of the flue, comparatively little steam is generated at this point. The vertical column is kept filled to a point above the top of the highest of the lateral tubes, so that all of these are constantly full of water. A circulating pipe starts from one side of the basin at the top and passes down into the mud drum beneath the grates. In this way there is a constant supply of water flowing from the top down to the bottom, which supplies the water evaporated. The circulation, therefore, is upward; and the water which has been heated in the basin under the steam dome deposits therein a portion of its sediment, and the remainder falls to the bottom of the mud drum beneath the boiler, from which it is readily removed by man holes located as shown on the drawing. The man-hole in the steam dome also enables the basin to be emptied and cleaned. It is claimed that the constant upward tendency of the steam which is generated from water that is practically pure causes no sediment to be deposited in the tubes.

The steam-dome is made of ample size to allow for the sudden withdrawal of steam by the engines.

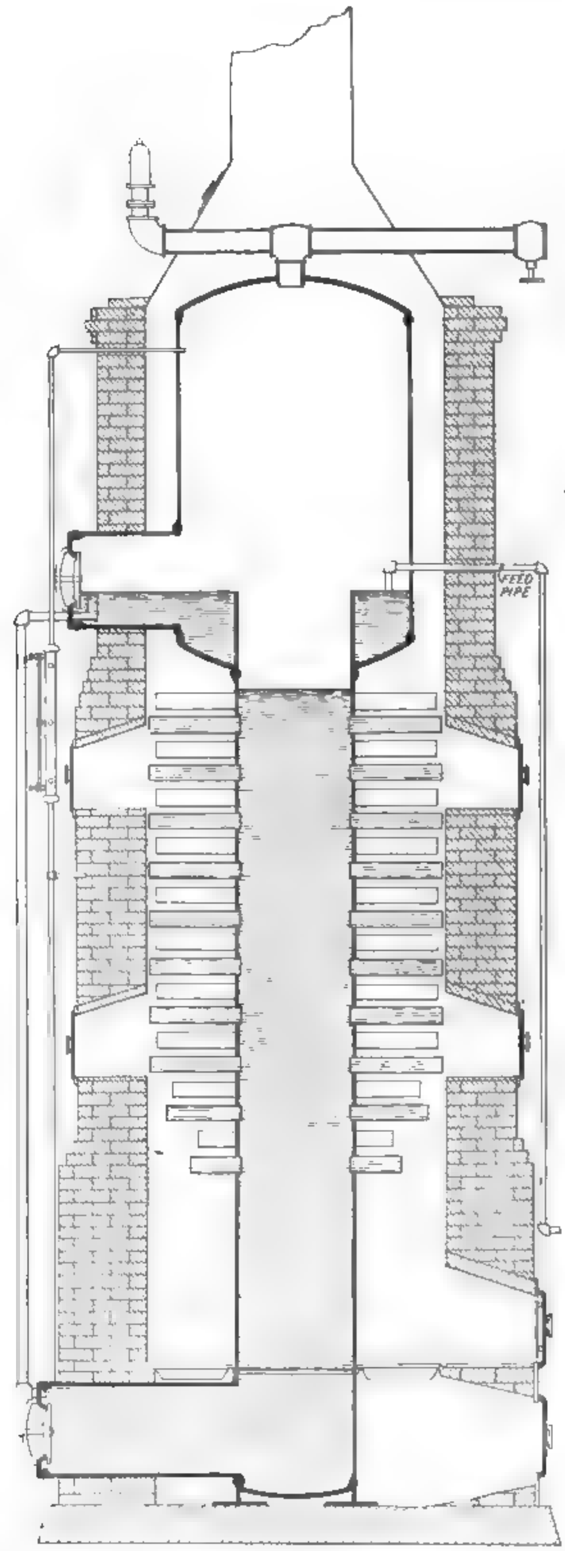
At a test made at the Falcon Tin Plate and Sheet Company's works, at Niles, O., in February last, 9.74 lbs. of water were evaporated per pound of fuel from a temperature of 212°. A memorandum of the fuel used showed that it was a low grade of bituminous coal. The test covered three upright boilers of 225 H.P. each. These boilers had a heating surface of 9.38 sq. ft. per H.P. The test was so successful that a 500 H.P. boiler for the company, at whose works these were tested, is now being built.

TANK ENGINE.

Designed by Charles Brown of Basle, Switzerland.

Some of our readers will remember the neat, ingenious and elegant designs of locomotives brought out by Mr. Charles Brown when he was Superintendent of the Locomotive Works at Winterthur. He is now located at Basle, and has sent us a photograph from which the engraving herewith was made, and from which it will be seen that he has "lost none of his cunning."

This engine is intended for small lines laid on common roads, of which many hundreds have been made. "It is peculiarly



THE ADAMS UPRIGHT WATER-TUBE BOILER.

adapted for this class of work," Mr. Brown writes us, "for the following reasons":

"1. The slide-valves are *underneath* the cylinders, and thus give self-acting drainage; no drain-cocks are required, no frightening of horses. This arrangement saves one-sixth of the fuel used by engines with slide-valves *above cylinders.*

"2 The working gear, connecting and coupling-rods, are all in the same plane.

"3. The bearings and springs are *outside* the wheels, and the *tanks inside*, which gives steady running on narrow gauges on uneven roads.

"4. Slide-valves are of the Church pattern, which are self-adjusting for wear, . . . never require readjusting. This is of importance in countries where no shops are at hand.

"5. All lubrication is by means of grease absolutely closed against intrusion of grit, saving of 90 per cent. of material, and vastly reduced amount of wear.

"6. All valves which have to be *ground* in from time to time are get-atable from the outside."

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

THE object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publication will in time indicate some of the causes of accidents of this kind, and help to lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with information which will help to make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we all intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in March, has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS IN MARCH.

Nuzum Mills, W. Va., March 1.—A freight engine on the Baltimore & Ohio Railroad exploded its boiler at this point today. Engineer Stevenson and Fireman Law were terribly injured.

Silicau, Mo., March 1.—A freight train on the Mississippi River & Bonneterre Railroad went through a bridge a mile south of Herculaneum this afternoon. The engineer, George Jump, was instantly killed. The fireman was seriously injured.

Brooklyn, N. Y., March 1.—A collision occurred on the Brooklyn Elevated Railroad at Broadway and Manhattan crossing, in which an engineer and fireman were badly hurt.

Winnimac, Ind., March 4.—A freight train on the Panhandle Line ran into the rear end of another train at this point this morning. Engineer Ide received injuries from which he will probably die. Fireman Merrill was thrown from the cab and badly scalded about the body. The engineer is said to have been asleep at the time.

Columbus, O., March 6.—A sleeper at the rear end of a train on the Pennsylvania Railroad jumped the track near this point this morning, and ran into a switch engine standing beside the main line. Fireman John McCormick was badly hurt.

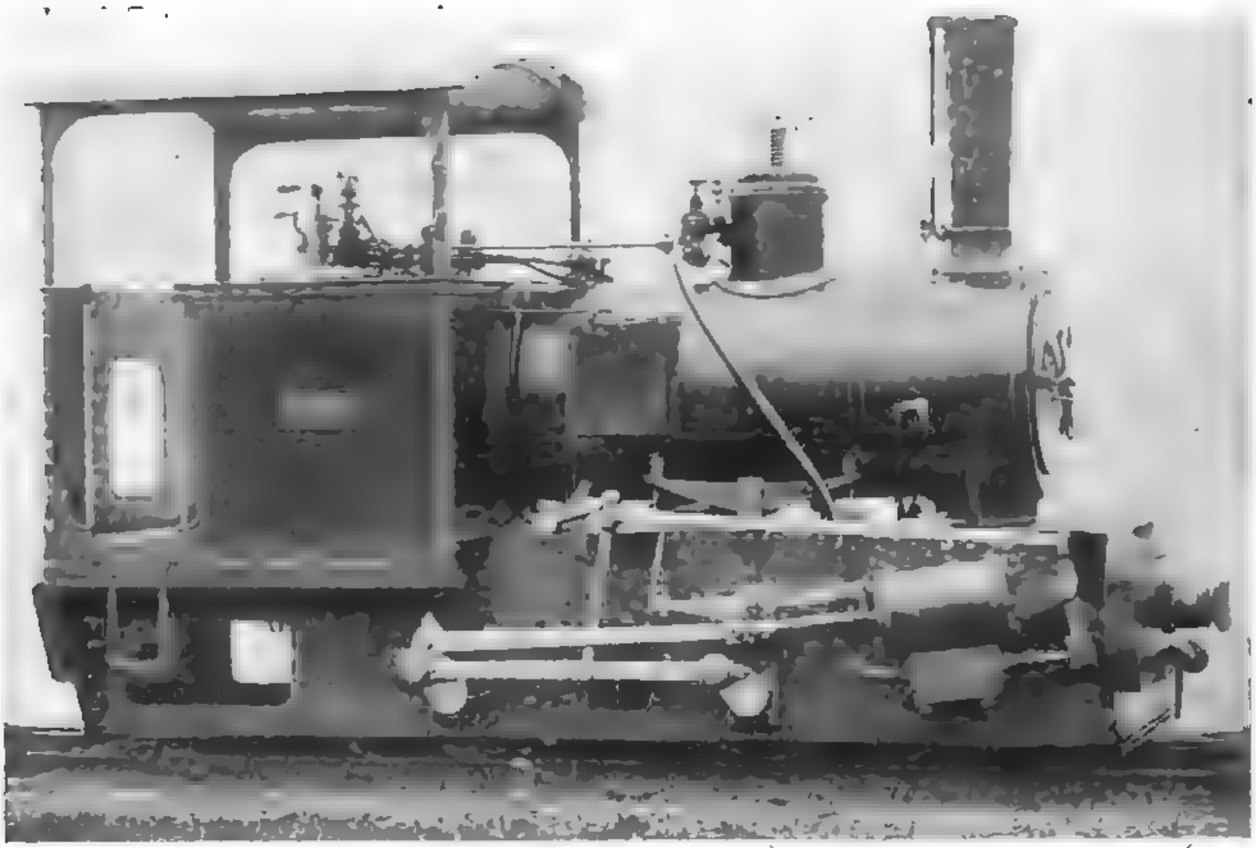
Gainesville, Tex., March 6.—An unsuccessful attempt was made to rob a passenger train on the Gulf, Colorado & Santa Fé Railroad early this morning. Two piles of ties were placed upon the track. The engineer and fireman saw the obstruction in time to jump, and escaped with a few bruises.

Pittsburgh, Pa., March 7.—An engine with five coal cars on the Pittsburgh, Youngstown & Ashtabula Division of the Pittsburgh & Fort Wayne Road, was swept off the track by a landslide this morning. None of the trainmen were killed, but Engineer M. Hubbard and Fireman George Jones were seriously injured.

Roanoke, Va., March 8.—A vestibule train on the Norfolk & Western Railroad, between Washington and Chattanooga, ran into a landslide 45 miles north of this city this morning. Engineer Jake Hardy was killed. Fireman Kroftsinger was thrown down the embankment of the James River and severely injured.

Wilkesbarre, Pa., March 8.—A locomotive on the Lehigh Valley Railroad exploded its boiler at White Haven to day. The fireman, John Lenox, was killed. The engineer was in the telegraph office for orders.

Oil City, Pa., March 9.—A freight train on the Western New York & Pennsylvania Railroad ran into a landslide 7 miles east of here this morning, causing the death of Fireman Martin.



TANK ENGINE, DESIGNED BY CHARLES BROWN, OF BASLE, SWITZERLAND.

LOCOMOTIVE RETURNS FOR THE MONTH OF JANUARY, 1894.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage. Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Av. Train. Passenger Cars.	Freight Cars.	Coal Burned per Mile. Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Cost per Locomotive Mile. Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Cost per Car Mile. Passenger.	Freight.	Cost of Coal per Ton.
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Atchison, Topeka & Santa Fé	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Canadian Pacific	602	...	492,375	649,873	295,610	1,437,858	2,387	...	...	...	...	...	81.13	...	...	4.09	13.59	0.38	...	5.78	1.58	24.81	...	...	3.10
Chic., Burlington & Quincy	542	...	...	...	...	1,449,971	2,675	4.72	17.78	...	...	...	69.96	...	...	4.55	6.89	0.28	0.88	7.26	6.06	18.89	...	...	1.41
Chic., Milwaukee & St. Paul	855	...	...	...	...	2,351,165	2,683	...	...	...	...	...	77.89	...	...	4.25	7.91	0.29	...	6.93	...	19.40	...	...	2.48
Chic., Rock Island & Pacific	564	...	477,450	789,820	375,722	1,642,992	2,918	...	...	62.91	8..94	46.96	71.09	...	...	3.39	7.05	0.96	...	6.26	0.42	17.35	...	...	2.14
Chicago & Northwestern	1010	...	810,744	1,282,623	564,515	2,657,882	2,631	...	...	...	...	...	96.79	...	...	4.14	8.51	0.81	...	6.33	0.92	20.19	...	...	1.80
Cincinnati Southern	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cumberland & Penn.*	28	23	5,858	25,148	...	31,006	1,346	...	...	...	...	...	89.18	...	...	9.97	4.46	0.35	...	...	2.39	17.19	...	...	...
Delaware, Lackawanna & W. Main L.	311	180	71,885	201,855	292,061	564,891	3,138	...	...	...	...	...	91.66	...	...	8.07	7.18	0.41	...	5.96	...	16.58	...	...	1.85
Morris & Essex Division	162	...	182,648	146,888	84,805	413,836	2,554	...	...	...	...	...	63.69	...	...	3.10	10.68	0.30	...	6.40	...	20.48	...	...	3.09
Hannibal & St. Joseph	67	67	...	...	...	252,916	3,775	4.77	15.98	...	...	...	87.82	14.65	7.87	2.87	6.00	0.11	0.41	6.69	0.06	15.61	...	...	1.44
Kansas City, F. S. & Memphis	146	...	94,065	223,489	93,690	411,272	2,817	...	...	...	...	...	70.80	...	...	2.93	5.80	0.24	0.48	7.26	...	16.63	...	...	1.55
Kan. City, Mem. & Birm	41	28	36,314	62,623	14,131	112,968	2,972	...	...	...	...	...	67.61	...	...	3.71	3.79	0.30	0.29	6.97	...	14.06	...	...	1.08
Kan. City, St. Jo. & Council Bluffs	35	36	...	...	...	181,968	3,771	4.71	18.04	...	...	...	70.69	16.70	4.94	3.69	6.87	0.16	0.33	6.26	0.04	17.57	...	...	1.99
Lake Shore & Mich. Southern	593	...	423,400	824,850	412,571	1,660,821	2,800	...	...	66.21	94.21	41.71	67.34	...	...	3.72	5.65	0.19	0.06	6.88	0.19	15.89	...	...	1.54
Louisville & Nashville	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Manhattan Elevated	...	304	777,302	...	68,644	845,946	2,782	...	...	...	...	...	45.58	...	...	3.00	8.80	0.20	...	9.00	...	21.00	...	...	4.08
Mexican Central	148	123	...	...	...	488,463	3,584	...	...	...	...	...	67.12	...	...	6.17	13.56	0.35	0.09	4.97	...	25.14	...	...	4.46
Minn., St. Paul & Sault Ste. Marie	108	90	84,885	147,570	37,285	269,740	...	4.67	18.10	...	...	...	58.71	...	...	4.57	14.71	0.28	...	6.48	...	26.04	4.90	1.64	3.50
Missouri Pacific	351	...	...	...	...	943,697	3,289	4.40	15.42	...	...	...	92.46	...	...	4.96	6.42	0.33	1.48	6.98	1.49	20.95	3.98	1.69	1.36
Mobile & Ohio	107	87	75,268	151,814	58,947	286,029	3,288	...	...	...	...	...	69.71	...	...	2.59	5.00	0.22	0.61	5.30	0.91	14.82	...	...	1.43
N. O. and Northeastern	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
N. Y., Lake Erie & Western	682	415	438,128	753,379	250,240	1,441,747	3,474	4.30	22.40	96.40	146.90	94.45	179.95	22.80	6.60	5.79	6.49	0.39	2.20	7.41	1.39	25.61	...	...	1.48
N. Y., N. H. & H., Old Colony Div.	...	...	363,674	143,440	169,224	676,938	...	3.80	14.90	...	...	...	66.18	19.00	6.30	3.44	10.94	0.69	...	7.22	0.94	23.53	...	...	...
N. Y., Pennsylvania & Ohio	275	184	125,217	398,896	116,635	640,748	3,482	5.20	16.40	62.20	129.20	105.86	105.59	...	...	4.63	5.86	0.39	2.57	6.86	1.19	21.56	...	...	1.06
Norfolk & Western, Gen. East. Div.†	...	...	93,427	267,168	49,305	409,900	2,562	4.96	20.26	55.97	131.74	...	93.55	10.87	6.50	4.95	3.98	0.28	...	...	...	9.91	...	...	...
General Western Division†	...	...	99,408	301,222	47,386	448,011	2,606	5.61	15.91	63.00	142.00	...	129.00	13.68	8.89	7.34	4.49	0.27	...	...	...	12.10	...	...	...
Ohio and Mississippi	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Philadelphia & Reading	...	...	427,086	287,068	733,578	1,447,732	...	...	...	...	...	...	80.80	...	...	4.95	4.94	0.34	...	5.79	0.46	16.50	...	...	...
Southern Pacific, Pacific System	738	680	637,165	654,653	256,593	1,548,311	2,458	5.31	13.48	...	...	...	66.62	...	...	5.11	15.56	0.19	2.10	7.20	1.27	32.51	...	...	4.75
Union Pacific	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6.18	0.09	15.57	...	...	...
Wabash	425	350	432,112	630,141	223,369	1,285,622	3,673	4.48	16.44	71.47	119.49	56.91	89.85	15.93	6.95	3.12	5.12	0.28	...	...	...	...	2.97	1.09	1.17
Wisconsin Central	149	108	115,263	169,651	48,746	333,660	3,239	...	...	...	...	...	87.07	...	...	2.30	9.80	0.17	...	7.17	...	19.44	...	...	...

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars. Empty cars which are reckoned as one loaded car are not given upon all of the official reports, from which the above table is compiled. The Union and Southern Pacific, and New York, New Haven & Hartford rate two empties as one loaded; the Kansas City, St. Joseph & Council Bluffs and Hannibal & St. Joseph Railroads rate three empties as two loaded; and the Missouri Pacific and the Wabash Railroads rate five empties as three loaded, so the average may be taken as practically two empties to one loaded.

* Switching engines allowed 6 miles per hour; wood, construction and gravel trains, 10 miles per hour.

† Wages of engineers and firemen not included in cost.

San Antonio, Tex., March 10.—Joe Miller, locomotive engineer on the Mexican International Railway, was killed by an engine turning over on him.

Montpelier, Vt., March 11.—An express train on the Vermont Central Railroad ran into two large boulders about three miles north of here this morning. Engineer McKenna was killed, and the fireman had his shoulder dislocated.

Capelton, Quebec, March 12.—A head-end collision occurred on the Boston & Maine Railroad near here to-night between an express train and a local. Engineer McDuffee and Fireman McPherson were instantly killed.

Pittsburgh, Pa., March 15.—A long freight train drawn by two engines ran into a landslide near Sample Station to-night. Engineer Ross and Develin were thrown from their cabs on to the mass of rocks and earth and received painful injuries.

Portland, Me., March 19.—A work-train on the Maine Central Railroad struck a section hand-car between Newport and East Newport this morning. The locomotive was thrown from the track, and the engineer, Frederick D. Wing, was killed.

Fort Worth, Tex., March 20.—The engine of a freight train on the Texas Pacific Railroad struck a horse near Santo to-day and ran into the ditch. Engineer W. F. Cross was fatally, and Fireman Youngblood seriously, injured.

Sylvan Station, Pa., March 23.—A passenger train was derailed by an open switch at this point to-day. The engine plunged over an embankment and the fireman was killed.

Amsterdam, N. Y., March 31.—A west-bound train on the New York Central Railroad, consisting of express cars, ran into a freight train at this point this morning. The engine ran down an embankment, and Engineer Wilkinson was injured.

Our report for March, it will be seen, includes 18 accidents, in which 8 engineers and 4 firemen were killed, and 6 engineers and 11 firemen were injured. The causes of the accidents may be classified as follows:

Boiler explosions	2
Broken-down bridge	1
Cattle on track	1
Collisions	4
Derailments	1
Landslide	5
Misplaced switch	1
Overturning of engine	1
Ran into hand-car	1
Train wrecking	1
	18

PROCEEDINGS OF SOCIETIES.

Meeting of Members of the Mechanical Engineers.—The next meeting of the Mechanical Engineers for the discussion of technical subjects will be held in the hall of the Society on Wednesday evening, May 9, at eight o'clock. The subject for discussion will be The Use of Water-tube Boilers in the U. S. Navy. An introductory "talk" or paper will be read by W. M. McFarland, Passed Assistant Engineer U. S. N. This will be the last of the series of meetings which have been held during the past winter.

Engineering Association of the South.—At the regular March meeting a paper was read on the Coal Handling Plant at Pikeville, Tenn. Owing to increasing competition among coal mines and consequent demand for better product, old, simple forms of chutes are now being superseded by those in which the coal is thoroughly cleaned and tenderly handled. The mine cars are carried to and from tipple by self-acting creeper chain. Coal is dumped on back tippler, eliminating large amount of breakage of coal usual in old-style tippler. Lump is made over shaking screens, 1¼ in. perforations, inclination 1¼ in 12. Coal is lowered gently into cars by specially designed chute, having had nowhere a direct drop of more than a few inches. Nut and slack are elevated together and separated on shaking screens, ¾ in. perforations, inclination 3¼ in 12. Good results are obtained from corrugating these screens. The uniformly sized slack made by this plant greatly improves physical properties of coke. The use of perforated metal shaking screens, compared with that of bar screens, increases both quantity and quality of salable coal. Capacity, 1,000 tons per day; cost, $4,400; estimated running expenses, $6 per day. The plant was designed and erected by Mr. J. J. Ormsbee, Superintendent, Sequatchie Valley Coal & Coke Company.

PERSONALS.

Mr. George O. Manchester, formerly of the Atchison, Topeka & Santa Fé Railroad Company, has been elected Vice-President and Treasurer of the Sargent Company, Chicago.

C. M. Mendenhall has been appointed Assistant Engineer of Motive Power of the united railroads of the New Jersey Division of the Pennsylvania Railroad Company, to take the place of Samuel Porcher, who has been promoted.

Mr. B. J. Williams, who has been Secretary and Treasurer of the Shelby Steel Tool Company, up to the present time, recently tendered his resignation, for the reason that the banking business with which he has long been associated demanded more of his time than he could devote and attend business with the Shelby Company. Mr. J. C. Patterson was elected his successor. The business of the company has been one of continued prosperity, the last month showing the shipment of nearly 3,850 ft.

OBITUARY.

Edward Barry Wall.

When those who are old and feeble, or others, from whom the hope and cheerfulness and buoyancy of life have been sapped by misfortune or illness, are taken away, death even then, if they are our friends or are still nearer to us, always comes as a surprise. But when one in the prime of life, and standing on the threshold of distinction, with a past career full of promise of future usefulness, and of a nature which charmed all who came under its influence, is taken, the announcement comes like a relentless blow to which we must submit reverently and resignedly, if we can. The sad news of the death of Edward Barry Wall came in this way to many of his friends and acquaintances, who had no previous intimation of his illness. He died in the Homœopathic Hospital, in Pittsburgh, on the evening of Sunday, April 1, after an operation for appendicitis. The immediate cause of his death was the shock from the operation, but his disease was complicated with peritonitis.

He was born in Kingsborough, N. Y., on April 25, 1856, and was the son of Professor Edward Wall, who occupies the Chair of Belles Lettres in Stevens Institute in Hoboken, and Sarah Berry Wall. His early education was received at the Brooklyn Polytechnic Institute and the Martha Institute in Hoboken. In 1872 he entered the Stevens Institute at Hoboken, and graduated in 1876. It was during this period that the writer first made his acquaintance. From the dates given above it will be seen that he was only 16 when he entered Stevens Institute. He was then short of stature for his age—and was extremely boyish-looking even for a youth of his years, but with a mind even more active than his body—and that seemed to be so overflowing with vitality as to be almost out of his control. He was then a frequent visitor to the office of the *Railroad Gazette* in search of information relating to his studies at the Institute. It was sometimes almost comical to hear from a mere boy, who did not appear to be more than 12 or 14 years old, inquiries for information about matters which the editors of that paper would have been only too glad to have received satisfactory answers from any source whatsoever. Any intelligent person who came in contact with him then could not help seeing that this seeming youth had in him the potentiality of a distinguished man. His jovial good-nature—such a marked characteristic of his later life—then fairly bubbled over, but was always under restraint and made subservient to his more serious duties. Notwithstanding his overflowing animal spirits, his nimble and inimitable wit, the elastic buoyancy of his nature, he never failed to treat those older than himself with that consideration which was, perhaps, their due. In later years, when the acquaintance of those early days ripened into a closer and more intimate friendship, the writer recalled, with a curious feeling of grotesqueness, the respectful deference with which he was treated by this youthful student, who later became such a charming companion and friend.

Before finishing his studies he was engaged for a short

time in making a series of experiments in boiler explosions, which were carried on at Sandy Hook. These experiments were made to throw some light on the cause of boiler explosions, which theretofore had been attributed to all sorts of causes excepting the true one—that of insufficient strength in the boiler to resist the steam pressure to which it was subjected. A destructive explosion was produced during these experiments simply by an over-pressure of steam.

On graduating at the Stevens Institute he was made salutatorian of his class, and soon after went to Altoona as an apprentice in the car shop, and worked there for about two years. He was afterward employed in the testing department of the Pennsylvania Railroad at Altoona.

In 1883 he was appointed Assistant to the Master Mechanic of the Pittsburgh, Cincinnati & St. Louis Railroad, at Columbus, O. In 1888 he was made Superintendent of Motive Power of that line, and was then noted for being the youngest man occupying such a responsible position in the country. About this time he became a member of the Master Car-Builders', the Master Mechanics' Associations, and the American Society of Mechanical Engineers. He was also one of the trustees of the Stevens Institute.

On June 24, 1892, he was married to Fanny Mitchell, daughter of General John G. Mitchell, of Columbus, O. A deep shadow was cast over his life by the death of his wife in childbirth, on August 12, 1893. A son named after his father survives them both.

At the opening of the World's Fair in Chicago the father was appointed Assistant to the Vice-President of the Pennsylvania Lines West of Pittsburgh, with his office in Chicago. During the Exhibition he was very much interested in it, and was one of the judges of awards in the Transportation Department. After the Exhibition closed he was appointed Assistant to the General Manager of those lines, with his office at Pittsburgh. His duties in this position were somewhat peculiar. The object in creating the office was to give some one, with technical knowledge and practical experience, control over the purchases of the road, so that not only would the prices which are paid receive proper consideration, but the value of the materials bought would also be submitted to the critical judgment of a competent person. He occupied this position at the time of his death. He was also a member of the Duquesne Club, of Pittsburgh, and had been a member of both the Chicago and the Columbus Clubs in those two places.

It is not easy, in a brief memoir like this, to do justice to his abilities and character. His striking trait was an exuberance of animal and mental spirits, with a constant effervescence of wit and humor, which was the perpetual delight of those who were not too dull to enter into the spirit of it. It should not be inferred from this that he was overmuch given to levity. It is true that he sometimes sorely perplexed his duller brethren, who had not the mental agility to follow him in the leaps and bounds of his pleasantry, over very ordinary and sometimes extraordinary matters. There was a deep seriousness in his character over which this jocose fancy was only a thin veil, but which nevertheless some never saw through. Although at the head of the mechanical department of a great railroad, it cannot be said of him that the bent of his mind led him in the direction of being a mechanical genius. It is doubtful whether he had any great love for mechanical matters. His aptitude and endowments seemed to incline him more in the direction of executive duties, to the control and management of affairs and men rather than to mechanical construction and design. But if we assign to the calling of an engineer the celebrated definition, that it is "the art of directing the great sources of power in nature for the use and convenience of man," then the subject of this memoir may rank high in that occupation. The shops of the Pittsburgh, Cincinnati & St. Louis Railroad, over which he had supervision, were noted among railroad men for being among if not *the* best ordered in the country. Those at Columbus and Indianapolis especially always excited the admiration of master mechanics and others competent to form opinions in such matters. In all subjects pertaining to mechanical engineering he had a very quick apprehension, sound judgment, and ever ready administrative ability—traits more valuable to his employers, probably, than mechanical genius would have been.

He was for a long time one of the most active members of the Master Car-Builders' Association, and for a number of years was one of its Executive Members and served on the Board of Directors. In that capacity his incisive good sense helped the Board out of many a tangle and difficulty. He never could be enticed from the real marrow of any question by a phrase or a prejudice. He seemed to have the faculty of not only seeing questions, but of weighing them, and his mind had the capacity—which is comparatively rare—of apprehending the *mass* of a question as well as its *surface*.

In the proceedings of the Association itself he was always very active, and served nearly every year on one or more committees of investigation, the reports of which he often wrote himself, or assisted in writing them by his advice and suggestions, and these were always of much value to his co-laborers and to the Association.

To him should belong the credit of introducing and securing the adoption of a resolution, by the Association, approving of the type of automatic car-coupler which is now the standard in this country. A retrospect of this action will be doing nothing more than justice to the subject of this memoir.

In 1883 a committee was appointed by the Car-Builders' Association to make a report at the next meeting, to be held in 1884, on Automatic Freight-Car Couplers, the purpose in appointing the committee and having the report made being the hope that it would lead to the adoption of some standard form of automatic coupler. At the meeting held in Saratoga, in 1884, the committee submitted a report, in which they referred to eight different couplers as "worthy of special mention," 12 more "as meritorious," and 13 more which "the committee have also examined;" and the report wound up with the negations "that the subject is one which should not be passed over lightly," and that "thorough investigation and prompt action is demanded," and recommending that a committee of experts to do various things—which would have been useless if they had been done—be appointed. The report was merely fatuous, but the purlieus of the convention were filled with the representatives of the various couplers, which were referred to in the report, and these men were goading on members to take some action. An excited discussion followed, which promised to be fruitless and purposeless. The members always spoke of their associate simply as "Wall," who then took part in the discussion by saying:

"I think that it is almost imperative that we should adopt something, or else own up that we cannot. There are a certain number of confusing questions that surround the matter of couplers. I think that we can here, this afternoon, decide on a certain number of principles which any coupler should fulfill. If we decide on these principles, then they will be known as the opinion of the Association, and inventors who will take the question up can see what conditions they must fulfill when they invent a coupler; and those who have invented couplers which do not fulfill these conditions will see that there is very little opportunity to present their coupler before this Association.

"If any one were going to hire a man to roll wheels, and somebody were to ask us to make specifications of that man, we could do so; we would say that the man must be healthy, strong, agile, quick. We can also say the same thing about a coupling. In order to bring this matter to an issue before this meeting, I would like to submit a motion.

"*That it is the sense of this Convention that any automatic coupling presented here should couple in a vertical plane*; by that, I mean should be able to slide up and down."

Later, in explanation of this motion, he added.

"The great advantage of a vertical coupler is that, notwithstanding the inequalities of the track, the different height of cars, you can couple with any kind of cars with a coupler that couples in a vertical plane."

Mr. Cloud afterward added: "I will move to amend the motion as it was put, and to introduce the word 'mechanically.' That is to say, that it is the sense of this Convention that the best coupler 'mechanically' is one which performs the coupling along a vertical plane."

This amendment was accepted, and in that form the resolution was adopted. Afterward Wall added—and with the light of more than a decade on this question his words seem prophetic—"I submit, Mr. President, that in passing the motion which has just been carried, we have done away with the link-and-pin coupling or any coupling which involves that principle. We have voted that it is the sense of the meeting that the coupler which best fulfills mechanical principles shall couple in a vertical plane; *that necessarily does away with links and pins.*"

The opponents of the measure did not realize at first that they were totally routed, and they tried to retrieve their lost ground, until finally the following resolution was ironically proposed, and was actually adopted, by the votes of those who opposed the original resolution:

"*Resolved*, That the Convention recommends to any railroads wishing to experiment with couplers not belonging to the most mechanically perfect class, as Janney's or Cowell's, to experiment with the following: The Archer, Ames, United States, Mitchell, Wilson & Walker, Conway Ball and Gifford."

It was never learned that any railroads "wished to experiment with couplers *not belonging* to the most mechanically perfect class."

By his courage and adroitness and the quick invention of the happy descriptive term, "*vertical-plane coupler*," the measure was carried through triumphantly, and has been and will continue to be the direct means of saving hundreds or thousands of lives, and preventing an untold amount of suffering and pain.

He always took a very active part in the business of this Association. Among the older members of this body was one, a man of long experience in his occupation, and with convictions which he was always ready to advocate. He was one of the few representatives left of the old-fashioned New England mechanic, with a strong down-East dialect, conservative in his views, but keen, shrewd and loquacious. He and Wall were the very opposites of each other in both body and mind—the one was tall and thin and resembled the typical presentment of Brother Jonathan, with a sharp, shrewd face, and with a mind which moved slowly, but with considerable momentum; the other was short and stout, with a face beaming with smiles and hilarity, and whose mind and speech were always quick, agile and incisive. What may be called the contestations of these two men afforded an infinite amount of entertainment and often much instruction to their fellow-members. Our New England friend would rise and state his proposition and opinions, always at considerable length, and deliver them like a broadside from an old-fashioned man-of-war. Wall would then hover around him somewhat like a modern torpedo boat about an ironclad, and at the first opportunity would deliver a shot, which went as direct to the vulnerable point of his opponent's facts or arguments as a shell from a rifled gun, and was often quite as destructive as such a missile would have been to a wall of wood. After such encounters they would both drum their forces to quarters with the utmost good humor on both sides, and, to speak colloquially, would again "lay for each other."

Of the many delightful incidents which have been current among Wall's friends, was one which occurred at a political meeting to which he was appointed a delegate. It should be mentioned, perhaps, that he took a deep—and it hardly need be added—an *intelligent* interest in public affairs, and had a leaning which inclined him in the direction of political life. Like many other good people, he could not brook the nomination of Blaine for the Presidency, and went as a delegate to a protesting meeting in Chicago. While there there was the usual amount of boisterous and more or less senseless oratory and enthusiasm characteristic of such meetings, and at the mention of the name of Lincoln three cheers were proposed, and when Garfield was mentioned there were more cheers, and at the mention of the names of other men and measures there was vociferous applause, etc. And now the speaker said, "These people have not seen the handwriting on the wall. [*Cheers.*] In the nomination of James G. Blaine [*again there were cheers*] they have invited us to a Belshazzar feast." "Three cheers for Belshazzar!" shouted Wall, and they were given until the roof rang, and before the crowd learned that they were cheering an ancient reprobate who had been dead some thousands of years and who probably has not been cheered since then.

In a letter to his brother, written only a few weeks before his death, Wall congratulated him in this brotherly way, so characteristic of his nature: "I was glad to learn that you came through your counsellor exam's with flying colors. There was nothing else for you to do, and we all had that cruel confidence in you which a fellow has no escape from."

Again, what could be more charming than this tender reference to his motherless boy, in the same letter in which he congratulated his brother:

"Barry," he said, "was charming at Columbus on Tuesday evening, fat, fresh and bright—no crying or muling either in his heart or at his little mouth—which, by the way, is very small in repose, but goes from ear to ear, like his uncle's, when he grins."

In writing a brief account like this, which can do such scant justice to the friend and companion of many who will read it, the sad shadows which are cast by the still fresh recollections of his charming nature lead naturally to a record of those traits which were most attractive to us who knew him, to his joyous life, his good-fellowship, his *Gemüthlichkeit*—as the Germans express it; and yet, if this side of his character were alone portrayed, it would not do full justice to those stronger traits which were revealed whenever there was occasion for their exercise. There was probably no young man engaged in what, for the want of a better term, must be called "railroading," of whose future so many flattering predictions have been made. His associates instinctively felt that there was a brilliant future before him. His talents, as has already been remarked, led him in the direction of executive duties rather than to those of the reflective mechanic, inventor, or engi-

neer. In the administration of affairs he had already won distinction, and those who knew him best felt that, perhaps, the only bar in the way of a more rapid promotion, a few more years of age and experience would remove. His life may be likened to a fertile field, which had been carefully cultivated and sown. The waving grain was full of promise, but, in this world, the full harvest will never be gathered.

The following notice of the death and recognition of the worth of the friend and companion of so many of our readers has been published, since the above was written, in the annual report of the President of the Pittsburgh, Cincinnati, Chicago & St. Louis Railway Company:

"While engaged in the preparation of this report, death has again deprived the company of the services of one of its most promising and valuable officers, Mr. Edward B. Wall, who, on March 1, 1893, was appointed Assistant to the First Vice-President, and transferred to Chicago, with the general supervision of traffic questions arising at that point, and particularly in connection with the Columbian Exposition. This office having been abolished in January, 1894, Mr. Wall was appointed Assistant to the General Manager, with special supervision of the operations of the Purchasing Department. His long connection with the Motive Power Department and general knowledge of transportation had thoroughly fitted him for discharge of responsible duties, and his sudden death, on April 1, has entailed on our company a loss which cannot be too highly regretted.

"By order of the Board.

"G. B. ROBERTS, *President.*"

General Notes.

Detroit Graphite Manufacturing Company have a contract for painting the iron work of four of the largest buildings in Detroit, including the Chamber of Commerce building with their L. S. G. paint.

Chicago, Milwaukee & St. Paul Railway Co.—After April 15, 1894, the general offices of this company will be located in the Old Colony Building, corner Van Buren and Dearborn Streets, Chicago.

The Baltimore & Ohio Railroad Company's World's Fair exhibit, which was shipped to Baltimore at the close of the Exhibition, is now being reloaded and returned to Chicago. It has been donated to the permanent Columbian Exhibition.

Messrs. Westinghouse, Church, Kerr & Co. have removed their office to a suite of four large connecting rooms on the sixth floor of the Havemeyer Building, in New York. This is one of the few firms who report a good business in these dull times.

William C. Baker reports that he is selling some thousands of the sure safety vent for his fireproof heater to many of the most prominent roads in this country. This vent is a solid frangible disk which is sure to blow out, and thus instantly relieve any excessive or dangerous pressure in the Baker heater.

The Armstrong Manufacturing Company, Bridgeport, Conn., find a good demand for their improved pipe-threading and cutting-off machines, which are built on honor and with the view of saving time and labor in their operation. The catalogue of this concern should be consulted by those who want the latest and best in this line of goods.

The Sheffield Velocipede Car Company, of Three Rivers, Mich., has developed the business of car making in so many different directions, embracing such a variety of cars, that its title has become misleading. The word "Velocipede" has therefore been dropped from its name, and the company is hereafter to be known as the Sheffield Car Company.

The Cleveland Twist Drill Company, of Cleveland, O., report that their grip sockets are selling faster than they can make them. They have just furnished the United States Government, at the Washington Navy Yard, six of each size, from No. 1 to No. 5 inclusive, being 30 sockets in all. As the naval officials never adopt a new thing without careful investigation, this speaks well for the merit of these sockets.

Riehle Brothers Testing Machine Company, of Philadelphia, Pa., have appointed Mr. Carroll B. Smith, 32 Builders' Exchange, Buffalo, N. Y., their Selling Agent for Buffalo and vicinity for the Riehle United States Standard Testing Machines and Special Testing Appliances, the Riehle Marble Molding and Countersinking Machines, Marble Sanders and Hold Cutters, Riehle-Roble Patent Ball Bearing Screw Jacks, Screw and Hydraulic Presses, and the Riehle-Anderson Safety Track Jack.

The Hoppes Manufacturing Company, Springfield, O., have received the contract for the purifiers to supply the boilers with pure feed water for the city electric light plant, now being built by the Public Lighting Commission of Detroit, Mich. The Hoppes purifiers having been selected after very strong competition. The order calls for seven 300-H.P. purifiers to carry 165 lbs. of steam working pressure. Each purifier is required to heat and purify 9,000 lbs. of boiler feed water per hour.

The Detrick & Harvey Machine Company, of Baltimore, have recently purchased from the Capitol Manufacturing Company, of Chicago, their business of manufacturing the well-known Adams bolt threading and Cook nut tapping machines. The excellent reputation of these machines for accuracy and durability is so universally established that it is unnecessary to go into details at this time. The Detrick & Harvey Machine Company have an excellent plant; and with the increased facilities of special machinery they are prepared to turn out machines of the highest grade of workmanship.

The Joseph Dixon Crucible Company, Jersey City, N. J., are putting a cycle chain graphite on the market, which for purity of graphite and usefulness is vastly superior to anything of the kind heretofore prepared. The graphite is not only of the choicest stock, but is ground to an impalpable powder and then reground with a high grade of lubricating oil. This material when applied to the chain of a bicycle penetrates to the bearings and thoroughly lubricates and protects them from wear and rust. The Dixon Company will shortly put the same material on the market in solid form for convenience of wheelmen who wish to carry it in the tool bag.

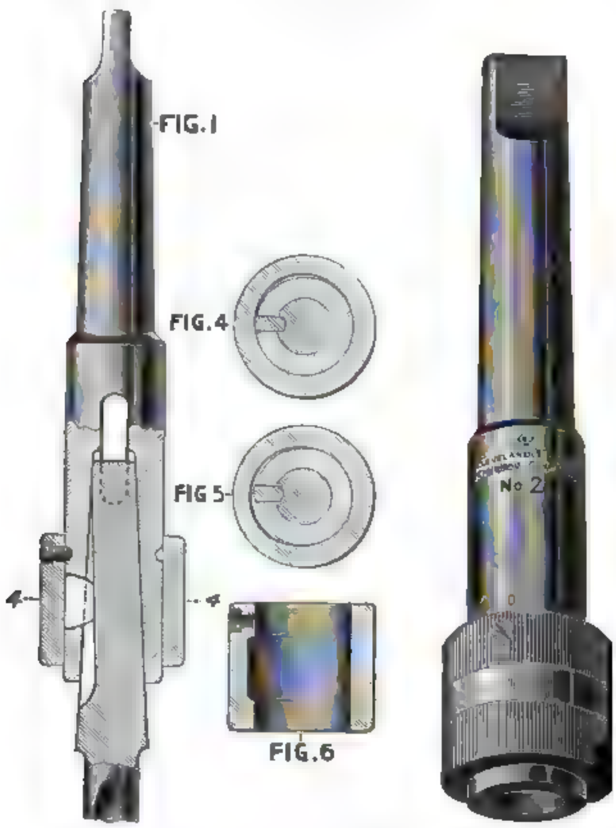
Pumps for the Navy.—Probably the largest order for steam pumps ever given out in this country by one concern was awarded to the George F. Blake Manufacturing Company by the William Cramp & Sons' Ship and Engine Building Company for a complete outfit of pumps for the U. S. cruisers *New York*, *Columbia*, and battle-ships *Indiana* and *Massachusetts*. The contract covered over one hundred steam pumps of all kinds, including independent air pumps for the main condensers, hydraulic pressure pumps for operating the guns, main and auxiliary feed pumps, main and auxiliary fire pumps, wrecking pumps, bilge pumps, water service pumps, engine-room oil pumps, drainage pumps, and steam pumps for the steam launches of the vessels named. Since the receipt of this order the George F. Blake Manufacturing Company have also closed the contract with the Cramp Company for a similar supply of pumps for the cruisers *Minneapolis* and *Brooklyn* and the battle-ship *Iowa*. The following U. S. naval vessels are also furnished with Blake pumps: *Philadelphia*, *Newark*, *Chicago*, *Boston*, *Atlanta*, *Maine*, *Puritan*, *Miantonomah*, *Manadnock*, *Terror*, *Amphitrite*, *Katahdin*, *Detroit*, *Montgomery*, *Marblehead*, *Yorktown*, *Dolphin*, *Machias*, *Castine*, *Petrel*, *Vesuvius*, *Iwana*, *Narkeeta*, *Wahneta*, and many others.

The Schenectady Locomotive Works are improving the opportunity of the dull times by replacing their old machine shop with a new two-story modern structure built of steel framework and brick filling. The new building will be 80 ft. in width by 368 ft. in length. The first floor will have two Sellers' electric cranes, traveling the entire length of the building, and covering all the heavy tools used on locomotive frames and driving-wheels. The Phœnix Iron Company, of Philadelphia, have the contract for the steel framework of the building, while the masonry is being done by a local builder. The B. F. Sturtevant Company, of Boston, are furnishing their blower system of steam heating, which is used with success in a number of other departments of the works. The old machine shop, now demolished, was built in 1866, replacing a structure which at that time was destroyed by fire. The machine tools have been temporarily transferred to other buildings, and set up so no delay in filling orders will be experienced during the construction of the building. It is expected the new building will be completed in June. With the completion of this building these works will be the most modern in buildings and equipment in this country, if not in the world, the entire plant having been practically rebuilt and equipped with new tools during the past ten or twelve years. The works are also about to receive a large hydraulic flanging plant for flanging boiler-work, which is about completed by the Morgan Engineering Company, Alliance, O. This is the largest and most modern plant of its kind ever constructed for this purpose.

Manufactures.

NEW METHOD OF DRIVING DRILLS.

EVERY mechanic knows that the weakest point about the ordinary taper shank twist drill is the flattened end of the shank, which frequently twists off long before the drill is worn out, or, if it does not, it will often cut or ream out the flat recess in the socket. In either event the drill or the socket are forever after useless until considerable expense has been put on them in the way of repairs. The Cleveland Twist Drill Company, of Cleveland, O., have gotten up what they call a grip socket that entirely overcomes this, the only weak point in the modern system of taper shanks. This grip socket is fully shown in the illustrations. A steel key is let into one side of the ordinary socket, and its inner side engages in a groove or flattened place prepared for it on the shank of the drill. A slight turn of the eccentrically counter-bored sleeve or collar fastens or locks the key securely in its seat, and then the drill cannot be turned in its socket or pulled out. This key is so located in the body of the socket that the tang on the drill will fit into the usual slot or recess prepared for it, and in this way the socket has a double driving power. The advantages arising from the fact that the drill cannot be pulled



out till the collar is turned back and the key released are many, as heavy tools have a provoking way of dropping out of their sockets at most inopportune times, and many drills are dulled or spoiled by tapping them into place by a hammer. If this simple drilling device is put directly on to the drilling machine spindle, heavy undercutting can be done with boring bars, and the labor necessary to turn over heavy castings entirely avoided. These grip sockets will hold just as perfectly and securely straight shank drills, and can be furnished with $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{3}{4}$ and 1 in. holes for straight shank drills. The company propose to put this necessary groove in the shanks of all their drills so that they can be used in these grip sockets just as the purchaser may prefer. A drill that has had the tang twisted off can be made as good as new for use in this grip socket by milling a half round groove in the shank, or if it is not convenient to mill it, a flat piece can be filed or ground in the shank, care being taken that such groove or flat place has a taper the reverse of that on the outside of the shank, as shown in the section drawing of the illustration. The small cut illustrates the reducer or shell sockets used with the grip. The Twist Drill Company have applied the gripping device directly to several drill press spindles, and will furnish collars properly constructed for that purpose on application at a very trifling expense. They have put in special machinery for making these grips, and as all parts will be made to jigs or standards, they can furnish duplicate parts at any time.

THE BALL & WOOD COMPANY'S NEW VERTICAL ENGINE OF 600 H.P.

THIS company issued invitations to a number of engineers and others to visit their shops at Elizabethport on Saturday afternoon, March 31, to inspect a new vertical engine just completed for the Chicago Edison Company. A very "goodly" company availed themselves of this privilege, and spent some hours in inspecting the engine and works.

To the visitors "A Brief Description" of this engine was distributed, which is of sufficient interest to justify us in reprinting it:

Engineers and the public at the present time seem divided in their preferences between two types of engines—the slow speed, represented in its best form by the Corliss engine, and the high speed, in the various forms which have recently come so largely into use. The Corliss engine has been, and is now, the standard for economical consumption of steam; but the high-speed engine offers so many other advantages that, in many cases, it becomes unquestionably the better one for practical service.

Since the beginning of this rivalry between the two classes of engines, there has been a recognized place for an engine which possesses the best economy of the Corliss engine, and at the same time some of the undisputed advantages of the high-speed type, in the direction of higher rotation, smaller floor space and better regulation.

The recent advent of electrical dynamos, arranged to be placed directly on the engine shaft, has greatly emphasized the want above described, because of the great saving in cost of dynamos when higher rotative speeds are employed, and the desirability also of close regulation.

With increased rotative speed shorter stroke is permissible; and hence the vertical form of engine, with its many advantages, offers fewer disadvantages than when extremely long strokes are used.

The engine herewith described has been designed and built with the foregoing state of facts in view, and, it is believed, will meet the hearty approval of engineers.

Its chief characteristics are:

1. *Unexcelled economy*, obtained by minimum clearance spaces and correct distribution of steam.
2. *Moderately high rotative speed.*
3. *Superb regulation.*
4. *A cut off valve gear giving rapid cut off and wide opening of ports at all points* from zero to three-quarter stroke.
5. *Small floor space.*
6. *Special adaptation to driving direct connected dynamos*, by reason of the shaft being entirely unencumbered with valve gear at both ends outside of the pillow blocks.
7. *Desirability for mill work*, in the combination of economy and regulation.

A brief consideration of the foregoing features may not be uninteresting here as an accompaniment of the illustrations of this engine.

Economy of Steam.—The expression "unexcelled economy of steam" is often applied indiscriminately, and even to the most wasteful engines. Purchasers have learned to interpret this expression according to the probable performance of the engine as judged by well-known principles of steam engineering, established by careful tests. For instance, correct steam distribution and small clearance are features that are found in every engine that has made a record for small consumption of steam. The best steam distribution is undoubtedly obtained with some form or modification of the Corliss wrist-plate motion and valves, and the smallest possible clearance is obtained by placing these valves in the cylinder heads. The engine holding the world's record for economy at this writing has just this arrangement. For good reason, then, it has been adopted in the engine under consideration.

Rotative Speed.—The Corliss releasing gear practically limits the rotative speed to about 100 revolutions per minute, or less; but in the engine here described the automatic cut-off is obtained by independently operated cut-off valves placed inside the steam valves, and actuated by a specially designed governor. This arrangement places no restriction on rotative speed, which is decided by other considerations, and the aim has been to find a medium unobjectionable to the slow-speed advocates.

Regulation.—The governing mechanism of the engine must be of special interest to the student of valve gears. Beginning with a well-known form of shaft governor, the principles of which have attracted the attention and admiration of the ablest engineers of the day, the superb regulation thus obtained is made effective by transmitting the necessary motion to the cut-off valves through a special wrist-plate device, in which a compound motion is obtained, and the cut-off valves at all points of cut off operate relatively to the main valves just as though the latter were standing still, thus preventing wire drawing of steam at any point of cut off.

Wide Ports and Rapid Cut off.—The location of the valves in the cylinder head, giving as it does the shortest possible ports, permits of their being of ample capacity without an appreciable increase of clearance.

The peculiar motion of the cut-off valve utilizes these wide ports to the fullest possible extent, and the cut-off motion at every point from zero to three-quarter stroke is a rapid one, in fact as rapid as is obtained from the releasing gear, because of the higher rotative speed of the engine.

Another feature of great importance in this gear, particularly with compound engines, or where moments of excessive overload occur, is its ability to cut off at three-quarter stroke, while the Corliss gear is limited to about half stroke.

Small Floor Space.—This feature may or may not be of special interest to the purchaser. In most cases floor space is valuable, and often extremely so. The compact form of this engine recommends it particularly to those who are limited in this direction.

Direct-driven Dynamos.—While the engine that has been described is eminently suited to any service requiring stationary engines of the highest efficiency, it has special features of adaptability to the work of driving electrical dynamos built upon the engine shaft and free from any encumbrance, and may each carry a dynamo or belt wheel if desired. It has already been described in regard to its rotative speed and close regulation, both of which add greatly to its value in this service.

Manufacturing and Mill Work.—Too much emphasis cannot be given to the advantages found in uniformity of speed under all conditions of load. In spinning and weaving this is especially true; and we offer to mills something not heretofore obtainable in the combination of this regulation and steam consumption, with the further advantage of safety in the use of wheels of small diameter. Fly-wheel accidents, fatal to life and property, are common to slow-running engines possessing wheels of excessive size and inferior governing mechanism; and, we believe, in the engines of our design these serious risks are overcome.

ALUMINUM DRAWING INSTRUMENTS.

The Bennett Manufacturing Company have submitted to us a considerable number of letters from draftsmen in different parts of the country, testifying to the satisfaction they have derived from the use of their drawing instruments made of an alloy of aluminum.

Mr. William H. Wahl, Secretary of the Franklin Institute, writes that he "finds the specific gravity of the sample of aluminum alloy you left with me a few days ago to be 2.96. Pure aluminum is 2 6.

"Considering the remarkable increment of stiffness and hardness your alloy possesses in comparison with pure aluminum, the comparatively small increase of specific gravity is interesting to note. You certainly secure these advantages without appreciable sacrifice of lightness."

At the last meeting of members of the Society of Mechanical Engineers specimens of nickel aluminum was exhibited which had been sent by Mr. Alfred E. Hunt, of the Pittsburgh Reduction Company. One specimen was a rectangular bar 18 in. long, $1\frac{13}{16} \times \frac{1}{4}$ in., which was bent in the middle and had a permanent set of $1\frac{1}{8}$ in.

"This," Mr. Hunt wrote, "had been tested under transverse test, it taking 400 lbs. to deflect the sample to the amount of the one sent, the distance between the supports being 16 in., *C* to *C*. A similar piece of 66,000 lbs. tensile strength steel, with 23 per cent. elongation in 8 in., took exactly the same load—400 lbs.—to deflect to exactly the same amount.

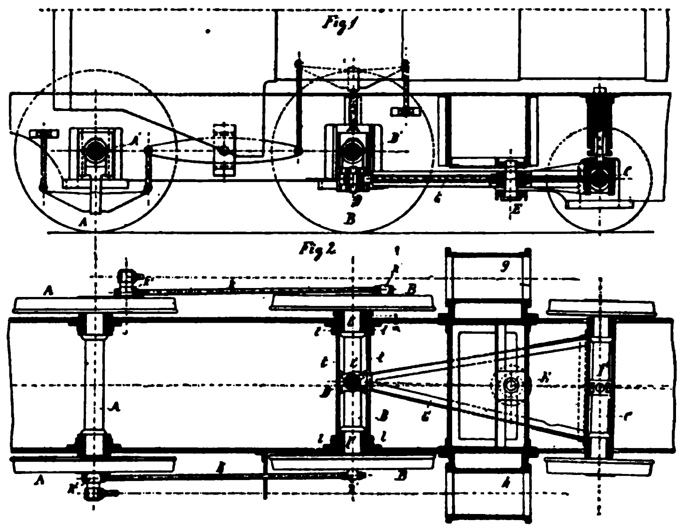
"I also take pleasure," Mr. Hunt wrote, "in sending you a sample of nickel-aluminum which has had a $\frac{3}{4}$-in. hole bored into it and enlarged by blows of a sledge upon a drift-pin to 2 in. This is a test which steel would by no means have stood."

This specimen was also exhibited. Mr. Hunt, continuing, said: "This is a new alloy which the Pittsburgh Reduction Company is just getting out, and which is a very interesting one, and promises to enlarge the field for aluminum considerably."

Recent Patents.

HELMHOLTZ'S LOCOMOTIVE RUNNING-GEAR.

Richard Helmholtz, "a subject of the Emperor of Germany, residing at Königsberg, East Prussia, Prussia, Germany," has patented the arrangement of wheels and axles for locomotives shown in figs. 1 and 2. As will be seen, fig. 1 is a side elevation, the front part, or attachments to the truck wheels, being shown in section, and fig. 2 is a sectional plan drawn through the axles. The rear or trailing wheels *A A* are attached to an axle *A'*, which is held in axle-boxes in the ordinary way. The two boxes of the front driving-axle, *B'*, are both made in one piece and are held in jaws in the frame, and are fitted so as to have a certain amount of lateral motion which permits the axle and wheels to move with it. The truck axle-boxes on the axle *C* are made in the same way, and are free to move laterally. A triangular-shaped frame *G* is attached rigidly to these boxes, and is also pivotally connected



HELMHOLTZ'S LOCOMOTIVE RUNNING-GEAR.

at *D* to the front driving axle-boxes. This frame is also connected to the bed-plate or the smoke-box by a fixed pivot *E* and a spherical bearing shown in fig. 1. The coupling-rods *k k* are also connected to the crank-pins *k' k'* by ball joints.

From the engravings it will be seen that the front driving-wheels *B B* and the truck wheels are free to move laterally in relation to the locomotive frame, and it will also be seen that if the one pair moves sidewise in one direction that the action of the truck frame about the pivot *E* will move the other pair of wheels in the opposite direction. The number of this patent is 564,320, and is dated February 6, 1894.

VON BORRIES' COMPOUND LOCOMOTIVE.

Mr. August Von Borries, of Hanover, Germany, has patented the form of intercepting valve illustrated by figs. 3 and 4. In his specification he describes his invention as follows:

"It relates to valve apparatus for compound engines whereby an engine provided therewith can be worked at will either as a compound engine, or as a non-compound engine, as, for instance, when it is desired that the power of the engine should be temporarily increased to meet special demands above the normal working average; as, for example, in the case of a locomotive, for ascending an incline, for starting a heavy train, or for shunting rapidly. According thereto within a suitable valve case are arranged two connected piston-valves that control passages between the receiver and the low-pressure cylinder, between the receiver and the low-pressure exhaust passage, and between a high-pressure steam-pipe and the low-pressure cylinder. One of these valves, hereinafter called for distinction the exhaust-valve, is larger than the other, and serves when the engine is working compound to prevent the passage of steam from the receiver to the low-pressure exhaust passage direct. The smaller valve, hereinafter termed the steam-valve, is under these circumstances inoperative, but by admitting live steam behind it, both it and the exhaust-valve will be automatically moved into such positions that the exhaust from the high-pressure cylinder can pass from the receiver direct into the low-pressure exhaust-pipe, while the said live steam will pass at a reduced pressure into the low-pressure

cylinder, which thereby becomes for the time being a high-pressure cylinder, with a consequent augmentation of power in the engine.

"Fig. 3 and 4 are longitudinal central sections of valve apparatus constructed according to this invention, fig. 3 showing the valves in position for working the engine to which they are applied, compound, while fig. 4 shows the valves in position for working the engine as a non-compound engine.

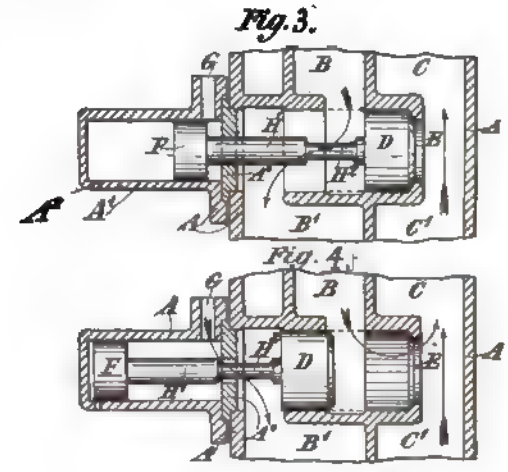
"*A* is a valve-case formed with a high-pressure exhaust passage *B B'* adapted to form part of the connecting pipe or receiver between the high and the low-pressure cylinders, and with another passage *C C'* adapted to form part of the low-pressure exhaust pipe or passage.

"*D* is a valve, herein called the exhaust-valve; it is in the form of a piston, and is arranged to control an exhaust-port or passage *E* connecting the two passages *B B'* and *C C'*, and to control the flow of exhaust steam through the passage *B B'* from the high to the low-pressure cylinder.

"*F* is a valve, herein called the steam-valve; it is in the form of a piston, and is arranged to work, as shown, in a cylindrical portion or extension *A'* of the valve-case provided with a steam inlet *G* that is in communication with the main steam-pipe, or direct with the boiler, or is adapted to be placed in communication with either by a cock or valve that may be worked by hand or from the reversing rod, or by a suitable construction of regulator valve, as will be readily understood without drawings.

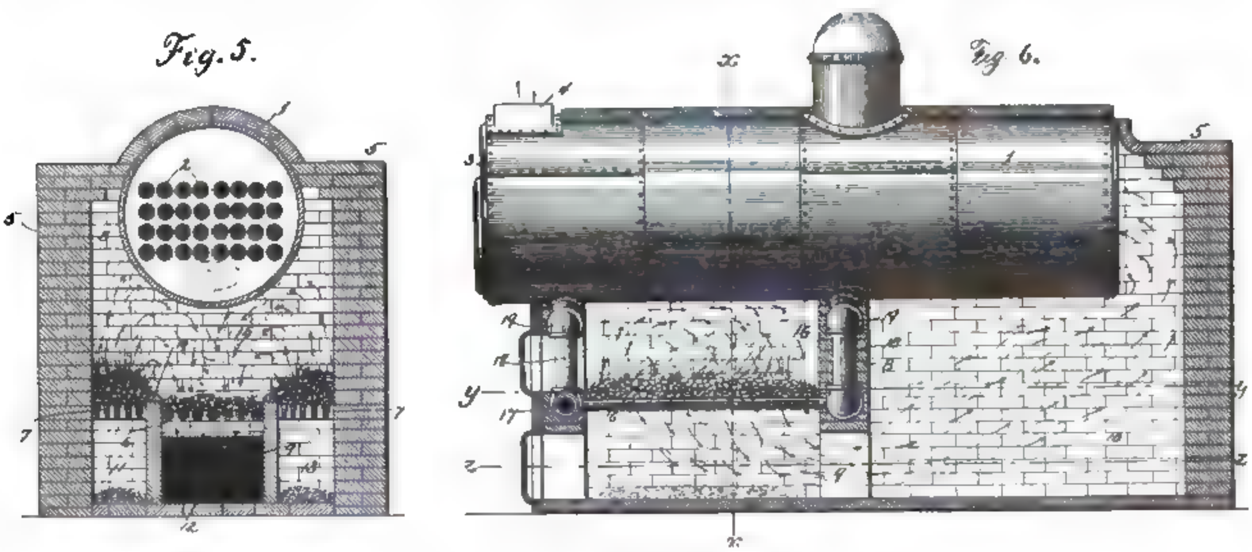
"A^1 is an opening for placing the front end of the extension *A'* in communication with the atmosphere, so that the valve *F* can make its outstroke easily.

"The two valves are connected by a rod *H*. The steam-valve *F* is arranged to control the passage between the said inlet *G* for live steam and the valve-chest of the low-pressure cylinder or cylinders. In the arrangement shown the rod connecting the exhaust and steam-valves *D F* is solid and made in two parts of different diameter, the part *H'*, of larger diameter, being arranged to work through a partition or diaphragm *A** placed between the cylinder in which the steam-valve *F* works and the passage *B B'*, and prevent live steam flowing freely to the low-pressure cylinder or cylinders until the exhaust-valve *D* is fully opened, as shown in fig. 4, at which time the part H^2 of the rod of smaller diameter will extend through the hole in the said partition or diaphragm, valve-chest of the low-pressure cylinder or cylinders, so that the engine will then work as an ordinary high-pressure or non-compound engine. When the supply of live steam to the steam inlet *G* is cut off, the valves will by reason of the greater pressure on the exhaust-valve of steam within that part *B'* of the receiver between the valve case and the steam-chest of the low-pressure cylinder, return automatically to their normal positions shown in fig. 3, and the engine will again work as a compound engine.



VON BORRIES' COMPOUND LOCOMOTIVE.

"When the engine is working non-compound and the thicker part *H'* of the valve-rod will have passed out of the hole in the intermediate plate or partition *A**, and formed a steam passage of such size as to reduce the pressure of the live steam that is then flowing through this hole (by throttling it), in such manner that the total force of the full pressure on the smaller valve *F* is kept equal to the total force of the reduced pressure on the larger valve *D*. As a consequence of this arrangement the following important results are obtained: If



PLUMMER'S SMOKELESS BOILER.

and leave a free passage for live steam to the end *B'* of the said passage *B B'*, whence it can flow to the low-pressure cylinder.

"By the arrangement described, when live steam is admitted through the said steam inlet *G*, so as to act behind or upon the inner end of the valve *F*, the two connected valves *D F* will be automatically moved by the pressure of the live steam on the steam-valve *F* into the positions shown in fig. 4. Th exhaust-valve *D* will then close the passage *B B'* between the high and low-pressure cylinders and open the exhaust port or passage *E*, so that each cylinder can exhaust separately into the exhaust-pipe or passage *C C'*, and the steam-valve *F* will occupy a position in which the part H^2 of the rod connecting the valve will extend through the hole in the partition or diaphragm *A**, and leave an annular opening, as shown, that will effect a communication between the main steam-pipe or boiler and the the consumption of steam at the reduced pressure in the low-pressure cylinder becomes greater, the pressure in the passage *B'* will be reduced a little thereby, causing less force on the larger piston and motion of both pistons to enlarge the opening H^2 through plate till the right amount of reduction is again reached. If the consumption of lower pressure steam is reduced, the pressure in *B'* will increase a little, thereby causing the pistons to move back a little and reduce the size of the opening H^2 till the right reduction is again reached.

"The amount of reduction is proportionate to the areas of piston-valves *F* and *D*. Thus if the smaller one is one-half the area of the large one the pressure in *B'* will be reduced to one-half. Furthermore, this arrangement possesses the excellent feature of reducing the steam pressure in *B'* to the proper amount to enable the total pressure on each piston to be equal when working non-compound, thereby preventing too great a

strain on the working parts, and enabling the adhesion of the driving-wheels of a locomotive to be utilized in the most advantageous manner."

The patent is No. 511,581, and is dated December 26, 1893.

PLUMMER'S SMOKELESS BOILER.

This invention contemplates a novel combination of a down-draft water-grate 6 and one or more up-draft fire-grates 7. (See figs. 5 and 6.) These different grates are relatively located with a series of solid grate-bars forming a separate fire-grate on each side of the water-grate. There is a single bridge-wall 8 over all the grates, and this is distinguished from the usual bridge-wall in that it is fitted closely to the under side of the boiler or other object to be heated, so as to prevent any passage of products of combustion between it and said object; or, in other words, it has an imperforate surface above the grates, but it is arched or otherwise supported across the space beneath the object to be heated, and in a plane below

Fig. 7.

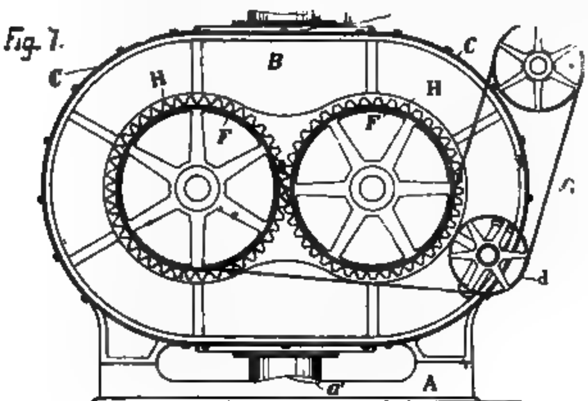
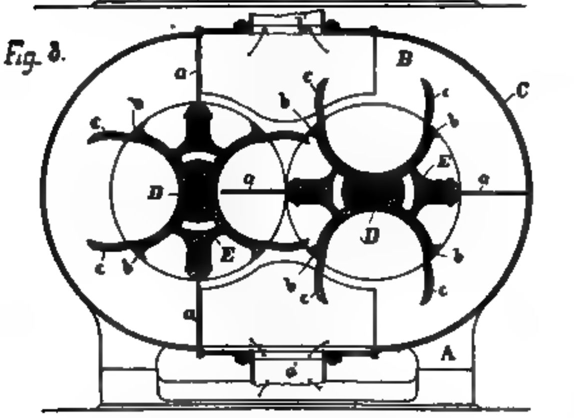


Fig. 8.



GREEN'S ROTARY BLOWER.

the plane in which the grates are located, so as to form what I term a fire-passage 9 centrally beneath the imperforate portion of said bridge-wall.

The operation is described by the inventor as follows:

"A fire is built in contact with all of the fire-surfaces and permitted to burn until glowing coals are produced thereon; then the side fire-surfaces and the central fire-surface are supplied with fuel alternately—that is, so that there would be a glowing bed of coals upon the said central fire-surface always when fresh fuel is thrown upon either of said side fire-surfaces, and so that the smoke from said side fire-surfaces will be caused to pass downward through said bed of glowing coals carried by said central surface, said central surface being supplied with fresh fuel at times when said side-surfaces have located upon them, or one of them at least, a glowing bed of coals. It will thus be observed that the central fire surface with its down-draft grate acts not only to consume the smoke generated by itself, but it acts as a smoke-consumer for the products of combustion discharged by the fire-surfaces located on each side and closely adjacent it, with the result that the smoke produced by all of the fire-surfaces is consumed prior to its discharge into the smoke-stack or chimney of the furnace."

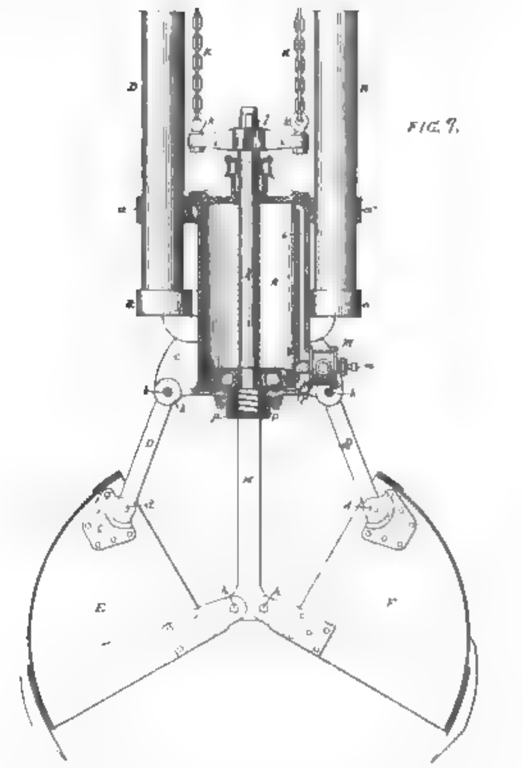
It would seem as though the operation of this grate would be improved if the side grates were made inclined toward the middle one, so that raw coal to be fed on the side grates and when it becomes incandescent could be moved to the middle or down-draft portion.

The inventor is William S. Plummer, of St. Louis. His patent is numbered 514,869, and is dated February 13, 1894.

GREEN'S ROTARY BLOWER.

Figs. 7 and 8 represent a very ingenious form of blower, which has been patented by Mr. Thomas W. Green, of Philadelphia, on February 20, 1894 (No. 515,212). The following general description from his specification with figs. 7 and 8, which represent respectively an outside and sectional view, will make the construction of this machine clear to the reader:

"I mount upon suitable driving-shafts, *D D*, lying in a support parallel to each other and inclosed in a proper air-tight casing, *C*, two iron frames *E, E*, commonly called revolvers. Each of these revolvers is provided with two blades or wings, *a, a*, for taking in the air or other fluid, and has the parts lying between the said wings or blades formed in such shapes that those parts of the two revolvers will fit into and upon each other as the revolvers turn around and thus form a lock or cut-off to prevent the escape of the air or water taken



SYMONDS' DREDGING-BUCKET.

in, except by the outlet provided and in the manner described. The two wings on each revolver are located exactly opposite to each other, and the cut-off mechanism midway between each of said wings. The revolvers are secured upon their respective driving-shafts in such a position that when the wings of one revolver are in a vertical position, the wings of the other revolver will lie horizontally and exactly at right angles to the first one. This position will allow the wings to pass each other without striking and the cut-off mechanism of one revolver to act in conjunction with the similar parts on the other revolver and thus forming a complete lock or cut off. The exact relative position of each revolver is positively maintained by means of two gear wheels secured upon the ends of the respective driving-shafts."

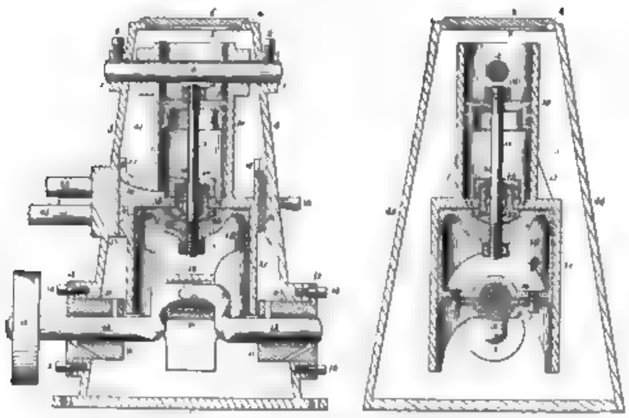
SYMONDS' DREDGING-BUCKET.

A, fig. 9, represents a cylinder provided with pockets, *a*, and guides or holding eyes, *a'*, in which are secured the opposite guiding poles, *B*, usually employed on dredging buckets and which extend as usual through guiding eyes at or near the extreme end of the boom. At the lower end of the cylinder are rocker-shafts *b*, which extend across the opposite sides of the cylinder and are adapted to suitable bearings *b'* thereon, the bearings being further supported by strengthening ribs *c* forming part of the cylinder.

Near each end of the shafts *b* are secured links *D*, which extend down to the opposite sections *E, E'* of the bucket and are pivoted at *d* to the bucket sections; the pivot point being strengthened by plates *e* secured to the inner surface of the

bucket and adapted to receive the pivot-pin *d*. The cylinder is provided with guides through which pass vertical connecting bars *H*, pivoted at their lower ends to ears *h*, on the inner or adjoining edges of the bucket sections and at their upper ends being rigidly secured to the arms *i* of a cross-head *I* carried by a piston-rod *I'*; the cross-head being provided also

Fig 10. Fig 11.



TRUESDELL'S COMPOUND OSCILLATING ENGINE.

with arms *i'* extending at right angles to the arms *i*, and being provided with eyes *k* to which are connected the chains *K* extending to the winding drum. The piston-rod *I'* is connected to a piston *J* of any suitable construction, and the cylinder is provided with the usual ports *l*, *l'* and a valve *M* controlled by cords extending from a lever *m* secured to the valve, to any suitable operating device on the dredge. The lower end of the cylinder is provided with a pocket, *P*, in which is a spring, *p*, adapted to cushion the piston when the bucket is opened.

In operation the parts are lowered by the chains *K* with the bucket open, as shown, and when the bottom is reached, the operation of the valve *M* admits fluid below the piston *J*, which forces it upward and thus carries the piston-rod *I'*, cross-head *I*, links *H* with it. As the portions *d d* of the bucket are held down by the superincumbent weight, the upward movement of *H* tends to turn the sections *E* and *E'* about the pins *d d* and thus close the bucket.

The weight of the bucket and the cylinder casing and the poles all tending to keep the bucket close to the bottom, while the pressure of fluid between the piston and the end of the cylinder causes the gradual closing of the jaws of the bucket and the latter is completely filled without any undue strain on the operating parts, as distinguished from the ordinary construction of buckets, where the operation of the hydraulic or other cylinder usually acts to raise the bucket during the closing movement and prevents the weight of the parts acting to keep the bucket at the bottom. During the descent of the bucket the piston *J* being at the bottom of the cylinder and resting against the spring *p*, the contact with the bottom is not detrimental to the machine and any sudden shocks or breakage are avoided.

The inventor of this device is Mr. Thomas Symonds, of Leominster, Mass. His patent is dated February 13, 1894, and numbered 514,788.

TRUESDELL'S COMPOUND OSCILLATING ENGINE.

Figs. 10 and 11 represent an ingenious form of engine, patented by Eugene E. P. Truesdell, of Belvidere, Ill. It hardly needs any description, as the engravings make the construction sufficiently clear. The high and the low-pressure cylinders 20 and 21 are cast in one piece and are suspended on the shaft 8, on which they can oscillate. The two pistons 27 and 28 are both attached to the rod 32, and the lower or low-pressure piston is connected directly to the crank *O*. The design, as will be seen from the engravings, is very crude, but the general plan by its general simplicity has much to recommend it. The patent is No. 515,180, dated February 20, 1894.

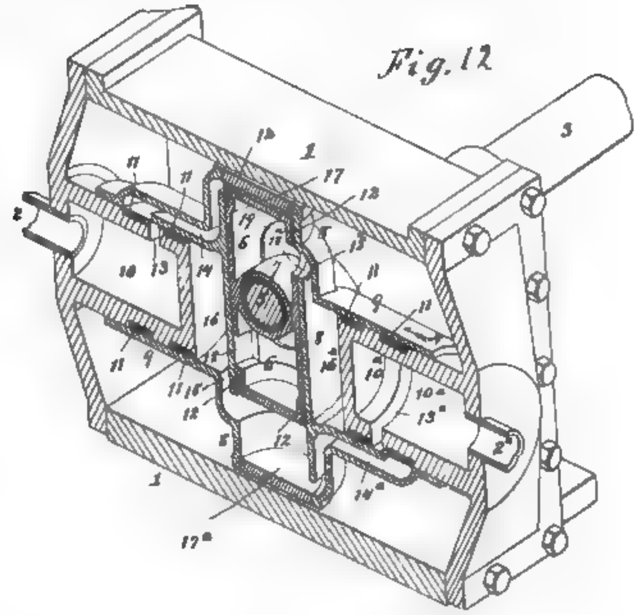
ATWOOD AND PERKINS' ENGINE.

Fig. 12 represents another ingenious form of compound engine patented by La Motte C. Atwood and N. W. Perkins, Jr., of St. Louis, Mo. In their patent the inventors say:

"Our invention relates to an engine in which there is a piston and a cylinder acting alternately on the crank of a shaft, to produce a rotary movement of the shaft; the piston acting to move the crank-shaft a quarter revolution, the cylinder then acting to move the crank the next quarter of a revolution, the piston then acting to move the crank another quarter of its revolution, and the cylinder then acting to move the crank the next and last quarter of its revolution."

Fig. 12 is a sectional isometric perspective view of the cylinders.

"The operation is as follows: Supposing steam or air to enter the hollow piston 10, through pipe 2, it will pass through the ports 13 and 14 to the space 17 between the upper head of the barrel 8 and the piston 6, causing the descent of the piston 6 and moving the crank 5 a quarter of its rotation, and at the same time carrying the cylinder 9 and barrel 8 to the right, until the latter is close to the end of the piston 10ª. As the crank 5 completes this quarter of its movement, the chamber 17 is opened to the chamber 16ª, through the port 15ª, and the air or steam, exerting its pressure between the barrel 8 and the end of the piston 10ª, will cause the cylinder 9 to be moved in the direction of the arrow *A*, and cause the crank 5 of the shaft 3 to be moved another quarter of its revolution, which carries the piston 6 to its lower position. The ports 13ª and 14ª are now opened to admit steam or air into the chamber 17ª beneath the piston 6. This causes the upward movement of the piston 6, and causes the crank 5 to turn the third quarter of its revolution, and moves the cylinder 9 still further in the direction of the arrow *A*. As the crank 5 completes this third part of its revolution, the port 15 is opened to the chamber 16, and the cylinder 9 is moved in the opposite direction to that indicated by the arrow *A*, causing the crank 5 to complete the last or fourth part of its revolution, and bringing the parts again into the position shown in fig. 1, and then the operation is repeated. The air or steam exhausts from the chambers 16 and 16ª through the ports 15 and 15ª, and passages 18 and 18ª,



ATWOOD & PERKINS' ENGINE.

in the piston 6 and barrel 8, and from there through a passage 19 into the interior of the housing, from where it escapes through an exhaust pipe.

"With this construction it will be seen that no valves are employed, other than those formed by the piston and cylinder themselves moving with relation to their ports. The engine, the inventors say, is an exceedingly simple and durable one, and is not likely to get out of order."

Their patent is No. 514,054, dated February 6, 1894.

GOLD'S PRESSURE REGULATOR.

The inventor of this device (fig. 13), Mr. Edward E. Gold, of New York, says of his invention that "it relates to reducing valves for reducing a fluid from a higher to a lower pressure, and especially to such valves as are adjustable in order that the pressure on the eduction side of the valve may be regulated at will. Pressure regulators of this character are commonly constructed with a regulating valve for choking or closing the steam passage through the casing of the regulator, and with a diaphragm exposed to the pressure on the eduction side of the valve and receiving the tension of a spring, so that while the spring tends to throw the valve open, the pressure of the steam against the diaphragm tends to close it. The fluid pressure on the eduction side of such a regulator is pro-

portional to the tension of the spring, so that by adjusting this tension from time to time the pressure may be varied at will. For this purpose a screw spindle having an operating handle is commonly provided."

Its construction is described as follows:

"Let *A* designate the valve casing, *B* the induction pipe, and *C* the eduction pipe. Within the valve casing is a parti-

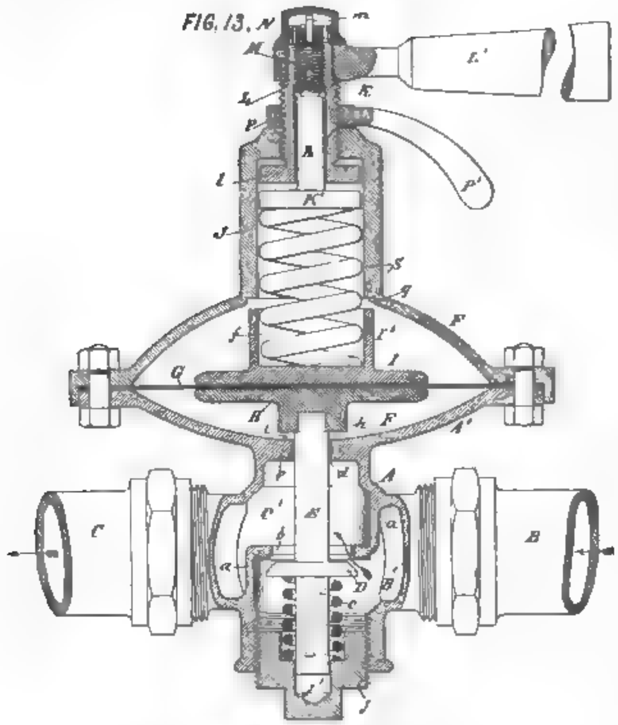


FIG. 13.

tion *a* dividing it into induction and eduction chambers *B'* and *C'*, and in this partition is formed a valve-seat *b* against which closes the regulating valve *D*, which is mounted on a valve-stem *E*, and receives the upward pressure of a spring *c* tending to close it. The valve casing *A* is formed with a diaphragm chamber *F* consisting of two halves or shells *A'* and *F'* bolted together at their margins and clamping between them the diaphragm *G*, which may be made of sheet metal or other suitable flexible material. The chamber *F* communicates with the eduction chamber *C'* by means of a restricted opening *d* through a partition *e*, this opening being very slightly larger than the diameter of the stem *E* which passes through it, so that a slight leak is left between the stem for the passage of steam around the eduction chamber and the diaphragm chamber. On the top of the stem *E* is mounted a disk or head *H*, which is held pressed against the under side of the diaphragm by the tension of the spring *c*. On the upper side of the diaphragm is a similar disk or head *I*, which is formed with a tubular upward extension *I'* forming within it a socket *f*, and in this socket the lower end of the regulator spring *S* is seated. This spring extends up within a chamber *J*, and its upper end presses against the enlarged head *K'* of a plunger *K*. The upper end of the chamber *J* has a screw-threaded opening through which passes a screw spindle *L*, the threads of which screw up or down in the opening when the spindle is turned by its handle *L'*. Within the spindle *L*, which is made tubular, is an adjusting screw *M* whose threads engage internal threads in the spindle, and whose lower end receives the upward thrust of the plunger *K*. On the spindle *L* is screwed a cap *N*, which serves the double function of concealing the screw *M* and holding the handle *L'* in place on the screw spindle. When the screw spindle *L* is adjusted up or down by turning the handle *L'*, it is clamped in position by a lock-nut *P*, which is provided with a handle *P'* for convenience in turning it.

"The induction pipe *B* being connected to a steam boiler or other reservoir of fluid under pressure, and the eduction pipe *C* being connected to a point at which it is desired to use the fluid at a lower pressure, the regulator serves to choke back the flow of fluid sufficiently to reduce its pressure to the required extent. The spring *S* being adjusted to the proper tension to accomplish this result, exerts a downward pressure upon the disk *I*, and consequently upon the diaphragm *G*, which pressure is communicated through the disk *H* and stem *E* to the valve *D*, and serves to press the valve open whenever the pressure on the eduction side of the valve falls below that pressure to which the regulator is set. As the valve is opened and steam passes through it and increases the pressure in the eduction chamber, steam flows from the latter through the space *d* into the diaphragm chamber *F*, and exerts an upward pressure upon the diaphragm until this upward pressure is sufficient to overcome the tension of the spring and press the diaphragm upwardly, whereupon the spring *c* will press the valve *D* upward against or nearer to its seat, thereby choking back the steam and correspondingly reducing the pressure. As the pressure on the eduction side of the valve falls, the spring again presses down the diaphragm and opens the valve, so that by a balancing of the downward pressure of the spring and the upward pressure of the steam, the regulator is caused to admit steam through the valve with just sufficient rapidity to keep up the pressure beyond it to that which is required."

The number of the patent is 508,183, and the date November 7, 1893.

HUMPHREY'S WRENCH.

The object of this invention (fig. 14), it is said in the patent, is "to provide means for forcing the movable jaw of the wrench against the stationary jaw after said movable jaw has been adjusted by the adjusting-nut which engages with the shank to which the stationary jaw is secured.

"*A* designates the stationary jaw to which the shank *A'* is rigidly attached, said shank passing through the handle to which it is attached by a nut as shown. The stationary jaw is provided on one side of the shank with a flat face *a* adapted to engage a nut, while on the other side of the shank the jaw is extended and provided with a curved face *a'* having dovetailed recesses in which are secured steel bits for grasping a pipe or tube. The clamping faces of the movable jaws are constructed similar to those of the stationary jaw, and by providing these faces the wrench can be used upon either a nut or pipe.

"The movable jaw, *B*, is provided with an aperture through which the shank passes, and on one side of said jaw are formed ears *b* between which is pivoted a lever *C*, and said lever is connected to a movable slide *D* by means of a short link *E*. The slide engages with the adjusting-nut *F*, said nut having an aperture threaded to engage with the threads on the shank of the wrench. The link *E* is bifurcated at its end which is pivoted to the lever, and at its other end is a projecting portion adjacent to which is formed shoulders which are adapted to bear upon the slide *D*, and the lever is so constructed that when the free end thereof is moved toward the shank or handle of the wrench to its fullest extent it will bear upon the projection *d*, and when in this position the pin which connects the link with the lever will be located on the inside of a line connecting the pivot-pin in the jaw and the one in the slide; thus locking the lever.

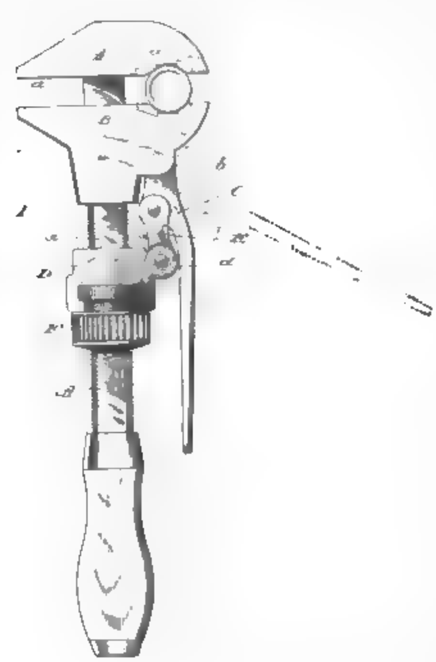


Fig. 14.

"By this device the movable jaw can be adjusted to the proper distance to grasp a nut or a pipe, and when it is desired to release the wrench it is only necessary to move the lever away from the shank or handle; or if desired the adjustment can be made and the lever employed for forcing the movable jaw toward the stationary jaw and upon the object to be grasped."

The patentee is Edgar A. Humphrey, of Columbus, Pa. His patent is numbered 514,752, and dated February 13, 1894.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

Formerly the RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

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NEW YORK, JUNE, 1894.

EDITORIAL NOTES.

IN commenting upon the paper read before the New York Railroad Club in January, by Mr. Joughins, on Iron Cars, *Indian Engineering* says that "it seems a little curious to an Indian engineer to find a question that has been decisively answered long ago for this country, being just opened in America. We may, perhaps, even congratulate ourselves upon not being so very much behind the times after all. Another singular point in detail is the discussion about and reluctance to use rivets. All that can be said is, riveted work stands perfectly well in India, and our wagons in the hands of native shunters certainly get a fair amount of knocking about, which would soon show up any weakness." In another column we publish an illustration of one of the iron cars that is now being manufactured by the Leeds Forge Company, and when we consider the great extent to which iron cars have been used and adopted by the railroads of other countries, it certainly does seem strange that this construction is so uncommon here.

THERE is little likelihood that the Master Car-Builders' Committee on Brake-Shoes will be able to make a report at the coming convention. The work which they have undertaken is so great that time enough has not elapsed since the commencement of the trials to wear out the shoes. We understand that 13 firms are represented in the trials. The standard of comparison is a soft cast-iron shoe made at the foundry of the Pennsylvania Railroad Company at Altoona. The general method of procedure is to equip one truck of a car or tender with the soft cast-iron shoes, and the other with the shoe to be tested, so that the number of brake applications will be the same. When this work is completed there will be a mass of data for some one to sift out and arrange, that will involve not only an immense amount of work, but demand very careful attention on the part of the committee doing it, for the contradictory testimony will be more than confusing, as that of things mechanical has a way of being. It is hardly probable, therefore, that we can learn the results of these investigations before the convention of 1895.

THE COMING CONVENTIONS.

To some of the old codgers who have been attending the railroad conventions for nearly or quite a quarter of a century, their annual recurrence comes with more or less feeling of pleasant anticipation, but shaded with many sad recollections. It is only needful to take the list of members of the Master Mechanics' Association beginning with 1870, to learn how many of them must now be crossed out, and how few remain to answer to their names. Beginning with Isaac Dripper, the first on the list for that year, and following it down, the names of H. M. Britton, N. E. Chapman, S. M. Cummings, J. A. Durgin, Howard Fry, Edwin Garfield, Samuel J. Hayes, C. F. Jauriet, J. W. Philbrick, James Sedgeley, W. S. Hudson, H. L. Leach, W. F. Turriff, and W. Woodcock must all be marked out. Of the active men of that time, James M. Boon, H. A. Little, Morris Sellers, J. H. Setchel, C. A. Thompson, Reuben Wells, and J. N. Lauder are still left. The annual reports from 1868 to 1893—twenty-five in all—form quite a library and bear evidence to the continuity of the work of the Association, even though their contents do not come up to the higher standard, which the technical education and the advances which have been made in mechanical engineering since the early period of its existence would demand. During the quarter of a century of the history of this Association and its sister organization, the Master Car-Builders' Association, they have both passed through many vicissitudes. The complaint is often made that they do not accomplish as much as they should. No human organization ever does. It was said by a distinguished statesman that "experience has always shown, and reason shows, that affairs which depend on many seldom succeed." When the co-operation of a considerable number of persons is required for the accomplishment of any purpose, all kinds of capacities must act for the achievement of a common end. In the direction and control of different sorts of people all degrees of intelligence, ignorance, prejudices, interests, and wrong-headedness must be encountered. Those who earnestly and honestly try to control and influence the action of considerable numbers of people must have, first, the intelligence to know what object should be aimed at, next unflagging persistence, infinite patience and unbounded charity to shape the opinions, adjust the views, tolerate the stupidity, deflect the obstinacy, lead the timidity, and sometimes crush the opposition, which is quite certain to be arrayed against any measure which goes counter to the practice, the habits, or is outside of the knowledge of those whose co-operation is required to carry such measures to a successful issue. The process by which wise political action is evolved out of representative bodies was very well expressed by a French statesman,* who said:

"Every society, according to its interior organization, its antecedents, and the aggregate influences which have or still do modify it, is placed to a certain extent in a position to apprehend truth and justice, and is in a measure disposed to conform itself to this law. . . . This sum of just ideas and loyal wills is dispersed among the individuals who compose society, and is unequally diffused among them, on account of the infinitely varied causes which influence the moral and intellectual development of men. The grand concern of society therefore is, that so far as either abiding infirmity or the ex-

* Guizot's "History of Representative Government."

isting condition of human affairs will allow, this power of reason, justice, and truth, which alone has inherent legitimacy, and alone has the right to demand obedience, may become prevalent to the community. The problem evidently is to collect from all sides the scattered and incomplete fragments of this power that exist in society, to concentrate them, and form them to constitute government. In other words, it is required to discover all the elements of legitimate power that are disseminated throughout society, and to organize them into an actual power—that is to say, to collect into one focus and realize public reason and public morality, and to call them to the occupation of power."

An exactly analogous process must occur in technical associations such as we are writing about, in order to "collect from all sides the scattered and incomplete fragments of the power of reason, justice, and truth, to concentrate them and organize them into an actual power." That is what the Master Mechanics', Master Car-Builders' and other similar associations have been aiming to do, with more or less unanimity of purpose, during the whole of their existence.

There have been and are still some influences which are more or less antagonistic to such purposes. A very considerable portion of those who attend the meetings go for amusement and pleasure alone, or chiefly, and a good many who are there each year have other aims and objects. The entertainment question is one which has come up annually, and been the cause of a good deal of irritation to some of those who are most interested in what should be the true purposes of the Association. As long ago as 1875 the Master Car-Builders' Association adopted the following preamble and resolution :

Whereas, The practice of entertaining the members of this Association by its friends has become an established custom, and has thus assumed somewhat the character of an obligation, to which those who have so generously dispensed hospitality have in a measure felt themselves obliged to conform ; and

Whereas, The expenditure of time and money for this purpose has in many cases been very much greater than the members of this Association have a right to expect should be devoted to their enjoyment ; and

Whereas, The expense of such hospitality has in some cases been interpreted as having a significance which has been the cause of embarrassment to members ;

Therefore, We desire by this resolution, first, to express our thanks for the liberality of our friends in the past ; and, secondly, to make the request in this public way that in the future there shall be no more expenditure of money for the public entertainment of members of this Association.

The record says, "the preamble and resolution were *unanimously* adopted." Some years thereafter a member of the Association was entrusted with the duty of collecting together the "Standard Dimensions, Forms of Construction, etc., adopted by the Master Car-Builders' Association," which were thereafter printed each year at the end of the annual reports, and also in a separate pamphlet for the convenience of the members. The person entrusted with the duty of making this compilation appended the above preamble and resolution to the other "standards." This, it is true, was done without any authority for so doing, but for years it appeared in the annual reports in the position described, but whether it was a "standard dimension" or a "form of construction" was never decided. A few years ago the list of standards was revised, and the committee charged with that duty discovered the pious fraud and omitted the resolution ; but it has never been repealed. It stands to-day as the deliberate action of the Association, although apparently it has had little if any effect. It may be said, though, that there is considerable feeling against the practices which the quoted resolutions were aimed at. Like the liquor traffic, though, these practices are difficult to control. Prohibition don't prohibit. High license, too, has little effect. What influence the hard times will have this year remains to be seen. Contributions for the entertainment of the members of the Association, their wives, their sisters, their cousins and their aunts, will probably be less liberal than in former years. Some of the members who are most deeply interested in the welfare and usefulness of the organizations referred to are earnestly looking for some means of controlling the exuberance of their friends' hospitalities. The Norwegian system is suggested. In that country it was found, as it has been everywhere else, that the traffic in alcohol could not be controlled so long as it was in the hands of irresponsible dealers. The State, therefore, has created organizations in that country over which they keep complete control, which are authorized to sell liquor under certain regulations, which the government is thus able to enforce. Let our railroad friends adopt an analogous plan—that is, appoint a committee charged with the duty of co-operating with the Entertainment Committees, and of restraining the expenditures of money at the conventions. Such a committee could thus exercise a reasonable restraint over some of the ambitious young men who become unduly elated when entrusted with the duty of hospitality. A great deal of absurd extravagance has often been indulged in which it would be for the good of the Associations if it were restrained.

Another question that is likely to come up again this year is some arrangement by which less time would be consumed by the two conventions. Few who occupy the dual positions of Locomotive and Car Superintendents can afford to devote two weeks to those meetings. To the consolidation of the two there has always been great opposition. It is not apparent either that any great gain would result therefrom. It makes very little difference whether the same or two sets of officers preside over the meetings devoted to locomotives and those devoted to cars. As the gain of consolidation is not apparent, the obvious course is not to do it ; but that will not prevent both meetings being held during the same week. Let the Master Mechanics hold their first meeting on Monday evening, which will enable them to finish up the preliminary routine business, and have the decks cleared for action next morning. Then devote Tuesday and Wednesday to the locomotive department, and let the first meeting of the Car-Builders be held on Wednesday evening, which will give them the whole of Thursday and Friday. If important business should remain for the Master Mechanics on Wednesday afternoon, it would be possible to continue their meetings on Thursday, and the two Associations could lap over each other. The Car-Builders could continue theirs on Saturday, if need be, or even extend them over to the following week in cases of emergency. With a little supervision of the Executive Committees to economize time, and of a Norwegian Committee to limit entertainments, it would be possible to accomplish as much in one week as is now done in the two, with perhaps fewer head and heart aches at the end of that time.

GRAPHITE AS A LUBRICANT.

To the Editor of THE AMERICAN ENGINEER :

Your review editor quotes the following paragraph from our pamphlet on "Graphite as a Lubricant" :

"The difference between a perfectly pure graphite and one almost pure, but still totally unfit for lubricating, cannot be detected by either sight or touch ; the buyer's only guarantee of the purity is the name and reputation of a responsible manufacturer." And adds :

"Now what we would like to know, and probably some of the readers of this pamphlet will be disposed to join us in our 'quest,' is how do the manufacturers know whether the graphite 'is perfectly pure'? If you can't see nor feel whether it is pure, how can it be known that it is pure ? In other words, the buyers and users of graphite would like to know how it can be tested to know whether it is pure or not."

This furnishes us with an opportunity that we are not slow to take advantage of. Your review editor evidently thinks that "seeing is believing, and feeling is the naked truth."

This old saw is not, however, of any use in testing graphite, though it may have its application elsewhere. The only way to "know" whether graphite is perfectly pure is to test it in a laboratory with the aid of chemistry. Therefore, unless he can make a laboratory test, "the buyer's only guarantee of the purity is the name and reputation of a responsible manufacturer." The Dixon Company, knowing the ore used, is reasonably sure of the purity of its product, but we do not stop there, we select samples at the different stages of manufacture and send them to the laboratory for test. Our purifying processes are continued until the required degree of purity is obtained. In case a test shows that the stock is not as rich as usual, that particular batch is turned into another channel and does not become "Dixon's Perfected Flake Graphite." The reason why "you can't see nor feel whether it is pure" is because the impurities are coated with the graphite, and become so smooth and black as to bid defiance to the sense of feeling and seeing. It is only when introduced into engine cylinders and bearings of machinery that particles of quartz and other impurities manifest themselves and begin their work of destruction. Pure flake graphite is now indispensable in every well-equipped engine-room or machine shop. Its uses are manifold, but common plumbago and black lead, which are so often offered for sale as lubricants, are worse than worthless. Perfected flake graphite has had an up-hill fight in overcoming prejudices that have been the outcome of experiments made with impure graphite and cheap plumbago.

JOSEPH DIXON CRUCIBLE COMPANY.

[The Dixon Crucible Company have not, we think, given a quite satisfactory answer to our inquiries. They say "the only way to 'know' whether graphite is perfectly pure is to test it in a laboratory with the aid of chemistry," and that they "select samples at the different stages of manufacture and send them to the laboratory for test." Now among our readers are a considerable number of people who have more or less knowledge of chemistry. What such people doubtless would like to know is the processes which are employed in the laboratory. Our correspondent's reply recalls the old story of the man who had but one leg. A woman expressed a great deal of curiosity to know how he lost the other one. He said he would tell her if she would agree not to ask any more questions. She agreed to this, and was told "it was bit off." Some of our readers will doubtless have the same kind of consuming desire to know how the Graphite Company test their products, after they "send it to the laboratory," that the woman had to know what it was that "bit off" the man's leg.—EDITOR AMERICAN ENGINEER.]

NEW PUBLICATIONS.

BEESON'S INLAND MARINE DIRECTORY. By Harvey C. Beeson, Chicago, Ill. 290 pp., 9¼ × 6¼ in.

This is the seventh annual edition of this Directory, and, like all other annuals, it has a tendency to grow with each issue. The contents of the book are, first, 32 pages of advertisements which will make rival publishers envious. These are followed by a portrait of the author or compiler and a list of American Steam-vessels of the Northwestern Lakes. In this and in other lists which follow the class, name of vessel, tonnage, date and place of building, name and residence of owner or manager, are all given. There are other similar lists of American sailing-vessels, vessels whose names have been changed, small steam-vessels of the Northwestern lakes, Canadian steam-vessels and Canadian sailing-vessels of the Northwestern lakes. These tables are followed by a number of others containing data and statistics relating to marine matters on the great lakes, instructions to masters of vessels, pilot rules, extracts from revised statutes, and ends with a classified directory of all the more important lines of trade connected with the marine interests on the Northwestern lakes. Many engravings of external and internal views of lake ships are scattered through the volume, which is of very great interest and value to all who are concerned in the immense traffic which is now carried on on these great internal highways of the continent.

HOW TO RUN ENGINES AND BOILERS. *Practical Instruction for Young Engineers and Steam Users* By Egbert Pomeroy Watson. Second Edition. Spon & Chamberlain, New York. 125 pp., 6¼ × 4¼ in., $1.

Mr. Watson is the well-known editor of *The Engineer*, which is published in New York, and is the author of a number of books of the "practical" type intended for men in charge of engines and other machinery. What he writes is always readable and often instructive, and has the merit that wayfaring and wise men can understand what he writes. Whether the other kind of people mentioned in the Scriptures comprehend his books we have never been able to find out.

The first four chapters of the book before us are on the management of boilers. These are followed by others in which the care of the piston, valves, valve-gear, governors, connecting-rods, cranks and crank-pins, journal-bearings, setting valves and eccentrics, making joints, care of condensing engines, pumps, etc., are all discussed, and many shrewd suggestions are given. The last chapter he calls "a little sermon," and is on the Highest Qualities Demanded—a suggestive title; and a good deal more might have been written under that heading with advantage and profit to his readers. He might, for example, have added, "Fear God and keep His commandments, for this is the whole duty of man," which would have been comprehensive.

TRADE CATALOGUES.

NEW ILLUSTRATED PRICE-LIST OF PATENT ELECTRIC VISES, JACK SCREWS, ETC. The Capital Machine Tool Company, Auburn, N. Y. 8 pp., 4½ × 7½ in. This little book is what its title indicates, but why the vises described in it are called "electric" does not appear. A little description of their points of superiority would, it is thought, be advantageous to both publisher and reader.

CATALOGUE AND PRICE-LIST OF MODERN MEASURING INSTRUMENTS FOR ALL TRADES AND SCIENTIFIC PURPOSES. E. G. Smith, Columbia, Pa. 16 pp., 3¼ × 6½ in. The principal instruments which are described in this little publication are caliper squares or graduated beam-calipers, vernier calipers, and screw micrometers, the manufacture of which is a specialty with the publisher.

THE RUE MANUFACTURING COMPANY. Philadelphia. Manufacturers of the "Little Giant," "Fixed Nozzle," and "Unique Injectors," Rue's Patent Boiler Washing and Testing Apparatus, etc. 16 pp., 5¾ × 9 in. The title describes the contents of this publication very fully. The different kinds of injectors are illustrated and their uses explained, and sizes, capacity, etc., given, and methods of attachment shown.

AMERICAN TUBE WORKS. Boston, Mass.: Seamless Drain Brass Pipe for Plumbing. 32 pp., 3¾ × 5⅝ in. The purpose of this little book is to commend the use of brass pipe generally, and that made by the American Tube Company in particular, for plumbing work. It gives a series of testimonials and a large list of buildings in which this kind of pipe has been used, and which one of the testifiers says, when "properly fitted is an everlasting job."

CONCRETE OR MONOLITHIC CONSTRUCTION. Ernest L. Ransome's Series of Inventions in the Manufacture and Use of Concrete. Ransome & Smith Company, 269 Dearborn Street, Chicago. 87 pp., 3¾ × 6¼ in. The principal invention described in this publication is Ransome's Concrete and Twisted Iron Construction. This consists in the use of square or rectangular iron bars, which are cold twisted so as to form a continuous bend with the concrete in which they are permanently imbedded. Very full information is given of the methods of employing this kind of construction for building purposes, monolithic subways, sewers, well molds, vault lights, etc.

REPORTS OF TWENTY-FOUR TRIALS OF THE HAZELTON OR PORCUPINE BOILER, *Arranged to Show the Performance of this Boiler under Varying Conditions of Service and with Different Grades of Fuel.* The Hazelton Boiler Company, 716 East Thirteenth Street, New York. 32 pp., 3¼ × 6½ in. The "porcupine" boiler resembles the same type as the one illustrated on p. 228 of the last number of THE AMERICAN ENGINEER. The little pamphlet before us contains the reports of 24 tests of the "porcupine" boilers made at different places and with different kinds of coal. These tests show the remarkably high average evaporation of 8.92 lbs. of water evaporated, at temperature of feed per pound of coal. The highest rate is 10.82 lbs. with bituminous coal, and the lowest 8.05 lbs. with buckwheat. Attacking a porcupine is proverbially unpleasant, so we will it to others to dispute the results of these tests, if they are disposed to do so.

AUTO-PNEUMATIC RAILWAY SIGNAL COMPANY'S DESCRIPTIVE CATALOGUE OF THEIR LOW-PRESSURE PNEUMATIC INTERLOCKING SIGNALS. Rochester, N. Y. 36 pp., 5¼ × 9 in. This is a well-written, well-printed, and clear description of the apparatus made by this Company for operating switches and signals by low-pressure air. It is illustrated with a number of wood-cuts and outline engravings which show the construction of the apparatus clearly. The title-page bears the name of H. B. La Rue as General Manager of the Company, who thus announces that he is ready to receive orders in his new position, in which his friends and acquaintances will wish him abundant success.

THE IRON CAR COMPANY. 115 Broadway, New York. 9 × 8¾ in., 24 pp. This elongated publication is a prospectus of a Company, the purpose of which apparently is to build cars for the transportation of fruits and other perishable products from the Southern States. The principal burden of the text is that the capital stock of the Company is $3,000,000, and that the present price of shares is $15 for one full-paid share of the par value of $100. The "enterprise," it is said, "is based on the mutuality of the interests of the people of one country, but separated by zones wide enough to create months of difference in climatic development." It would seem as though stock with such a "base" ought to be worth at least $15 for one full-paid share.

SOUVENIR CATALOGUE, WORLD'S COLUMBIAN EXPOSITION. W. & L. E. Gurley, Troy, N. Y. 64 pp., 7 × 10 in.

In "a sketch of their business and an announcement of their book," the Messrs. Gurley say that "so many of our customers are never seen by us, and never had an opportunity to visit our factory, that it occurred to us to take occasion of the World's Columbian Exposition to present this book, giving an idea of the various kinds of field instruments that we make, and some views of the place where they are made."

It opens with portraits of the two founders of the business, William and Lewis E. Gurley. The former died in 1887, the latter still takes an active part in the business.

Very good views of the outside and inside of the building occupied by the firm are given. These include views of all their principal workshops, their sales-room, and exhibit at the Chicago Exhibition. About 50 wood-engravings with brief descriptions are there given, which illustrate the principal instruments made by the firm. These include Transits of various kinds, Gradienters, Levels, Plane Tables, Compasses of various kinds, Odometers, and Current Meters. This firm have been pioneers in this business, and the book before us bears testimony to their well-earned success.

THE CONNERSVILLE BLOWER COMPANY, CONNERSVILLE, IND., *Manufacturers of Positive Pressure Blowers. for every Purpose requiring Air or Gas to be Delivered under Pressure.* 16 pp., 5¼ × 9 in. In this pamphlet the "Cycloidal Blower," manufactured by this Company, is very fully described. It consists of two revolvers or impellers, whose sectional form resembles a figure 8, and their length is about twice their major diameter. These impellers occupy the relation to each other which a vertical figure 8 would to one placed horizontally thus $\frac{8}{\infty}$, and each is carried on horizontal shafts, and the two are enclosed in a case and are driven by gear wheels outside the case. The outside contour of these impellers is composed of epi and hypo-cycloidal curves, and on the exact form of these curves much of the efficiency of the blower depends. In their catalogue the Company describe the method of shaping these impellers, their form and construction, and also a very ingenious journal-box intended to take up wear on the journals. The publication concludes with descriptions and illustrations of different classes of these blowers driven by engines and electric motors. With the exception of the first engraving in the book, they are all excellent, and are good, old-fashioned wood-cuts, than which no other kind of art can represent a machine so satisfactorily.

EARTHENWARE HOUSES. Charles Carroll Gilman, Eldora, Ia. 24 pp., 6¾ × 9¼ in. The contents of this pamphlet apparently are intended to describe some of the author's inventions to be used in the construction of houses, but it is not easy for a busy man to understand just what these inventions are from the pamphlet before us. Apparently it is for another process of making wood "incombustive," and for the manufacture of "fibrous brickwares." The latter is described as follows: "The formulæ for its manufacture differs so far from the others as to employ black soils largely with clays, too fat for brick-making, and commingling asbestos in greater or less quantities with the vegetable matter that enters the plastic composition, which, indestructible by the subsequent firing processes, remains in the burned wares as a fiber to bind them as jute does 'staff;' for great porosity is only had by excessive adulteration of the clays with combustible matter." This is not lucid. For the benefit of the author of this, and those who write other similar productions—and their readers—the remarks of Herbert Spencer will again be quoted: "A reader or listener," he says, "has at each moment but a limited amount of mental power available. To recognize and interpret the symbols presented to him requires part of this power; to arrange and combine the images suggested by them requires a further part; and only that part which remains can be used for framing the thought expressed. Hence, the more time and attention it takes to receive and understand each sentence, the less time and attention can be given to the contained idea; and the less vividly will that idea be conceived." Mr. Gilman's "symbols" have absorbed all the mental power we have been able to give to his publication.

THE DAYTON RAILWAY CROSSING-GATE. Manufactured by the Craig-Reynolds Foundry Company, Dayton, O. 19 pp., 6 × 8¾ in. In the pages of this book the points of superiority of the crossing-gates made by this Company are fully set forth. Two very good illustrations—half-tone engravings—show one set of them open and another closed. Two pages engraved from assembled scraps, cut from newspapers, which give accounts of crossing accidents, are intended to accentuate the necessity of having gates at such crossings. A poetic effusion—we were about to write eruption—occupies the last page. The closing stanza ends thusly:

> "Oh, you may toy with buzz-saws coy,
> Whenever they're in motion,
> Or on a feather in stormy weather
> Attempt to sail the ocean;
> And even jaw your mother-in-law,
> Who always does the bossing,
> But don't go near—if death you fear—
> The fatal railway crossing."

The pamphlet is admirably printed on coated paper, and there is every reason for thinking that the gates which this Company makes are as good or better than the best; but, really, can it be good business policy for them to publish such poetry? It would seem to incline every railroad manager to leave all his crossings unguarded, in order that he might have the satisfaction of killing as many poets of that kind as possible.

SOUTHERN FACTS FOR HOME-SEEKERS AND TRAVELERS. Mobile & Ohio Railroad. 48 pp., 4 × 7¾ in. Accompanying this "folder" a neatly printed circular was received, in which it is said that it—the folder—"contains complete time tables and other detailed information regarding the road, its officers and agents, and gives the population and altitude of all of the stations; it contains, in addition, a great fund of information regarding the South in general, and our section in particular, condensed into a small compass"—all of which we will confirm.

It is illustrated by some fairly good engravings made from photographs, one of which "shows strawberries, lettuce, onions, celery, cabbage, and turnips, all gathered on the day the photograph was taken. Had the photographer wished," it is said, "he might have also shown in the photograph from the same garden, parsnips, beets, leeks, shallots, radishes, salsify, carrots, and parsley."

Another engraving shows the Healing Springs in Alabama, which are said to be a positive cure for a number of ills, to some of which nearly all full-grown people are subject. It is also said that there are 11 springs, all different. There are enticing engravings of turnips weighing 12 lbs. each, a view of Hon. E. M. Hudson's grape vineyard at Beaver Meadow, Ala., an apple-tree in Tennessee bending under a load of 30 bushels of apples, and a wagon load of Northern land-seekers looking at lands on this road. We confess that we like the looks of the Southern turnips, cabbages, strawberries and grapes better than those of the Northern land-seekers. Probably most readers of this "folder" would rather have the vegetables which are depicted for neighbors than the land-seekers. Pleasantry aside, this publication is full of interesting information of the country through which the Mobile & Ohio Road runs, and on reading it one is strongly tempted to abandon such drudgery as editing a technical paper implies, go South and buy one of those farm tracts of 80 acres, which this "folder" tells us "can be obtained within 2 miles or less

of the railroad, that will produce early fruits and vegetables; most of the cereals, grasses, etc., and where good health and water are guaranteed, for $200."

Those interested in the South, or contemplating emigration, are recommended to write to Mr. E. E. Posey, General Passenger Agent of the Mobile & Ohio Railroad at Mobile, Ala., who will send them a copy of this interesting publication.

BOOKS RECEIVED.

Primer of Navigation. By A. T. Flagg, M.A. 104 pp., 4 × 6 in. London and New York: Macmillan & Co. 104 pp., 4 × 6 in., 35 cents.

Transactions of the American Institute of Electrical Engineers. Vol. X. 719 pp., 5¾ × 8¾ in. Published by the Institute, 12 West Thirty-first Street, New York.

The Magneto Hand Telephone. Its Construction, Fitting up and Adaptability to Every-day Use. By Norman Hughes. New York: Spon & Chamberlain. 80 pp., 4½ × 6 in., $1.

THE MANUFACTURE OF ALUMINIUM.

"At a recent meeting of the Manchester Association of Engineers, Mr. W. S. Sample, of the Metal Reduction Syndicate, Limited, Patricroft, near Manchester, read a paper on "The Manufacture of Aluminium." After a brief and interesting reference to the history of the metal, and the various improvements in the methods that have from time to time been adopted in its manufacture, the author gave a detailed description of the Hall process, which was patented in the United States in 1889, and which may be regarded at present as holding the field in the output of this comparatively new metal.

The Hall process consists of dissolving alumina in a fused bath of aluminium fluoride, and the fluoride of a metal more electro-positive than aluminium, and decomposing the alumina by passing an electric current through the bath. In practice the fluorides of sodium and calcium are usually added.

This process was first worked by the Pittsburgh Reduction Company, of Pittsburgh, Pa, in 1888, and in 1890 works were started in England by the Metal Reduction Syndicate, Limited, at Patricroft, near Manchester.

As the electrolytic processes as operated at present are very similar, the method of operating the Hall process may be taken as representative of the art at the present time.

Given an electric current of large volume and small tension, a number of carbon-lined steel pots are placed in series in the circuit, the pots forming the negative pole or cathode, and carbon rods attached to adjustable copper rods forming the positive pole or anode. The circuit being closed, by making contact between the carbon rods and the carbon lining of the pots, the current is turned on, and electrolyte added to each of the pots. The electrolyte is soon fused by the heat generated by the resistance of the pots to the passage of the current, and when sufficient bath has been fused alumina is added and the decomposition begins, the aluminium going to the bottom of the pot, which is the negative pole, and the oxygen going to the positive pole, combining with the carbon anode and escaping as carbonic acid gas. When the bath becomes exhausted of alumina or ore the resistance materially increases, as indicated by a meter attached to each pot, and more ore is added, thus restoring the normal working. From time to time, as metal accumulates in the bottom of the pot, it is either tapped off or ladled out, and run into molds as required. The electrolyte is unaffected by the current, the small loss which occurs being due to volatilization, and the process, once in operation, continues for months. The process is essentially a continuous one, working day and night, and the only limit of a run is the necessity for repairs to the machinery, and a holiday for the workmen.

The materials necessary for a pound of metal are:

2 lbs. anhydrous alumina,
$\frac{1}{10}$ lb. of electrolyte,
1 lb. of carbon.

The power required in this process is 18 electric H.P. per hour per pound of metal, although somewhat better results have been obtained. It will thus be seen that power is an important item in cost, and accounts for the exclusive use of water power on the continent, and the anticipated removal of the plant of the Pittsburgh Reduction Company to Niagara as soon as the turbines of the Niagara Falls Power Company are in place.

At present the electrolytic processes are the only ones used for the production of aluminium, and it does not seem probable that any better or cheaper methods will be discovered, although we are continually hearing of new processes, for which claims are made that the metal can be produced direct from clay or bauxite, at remarkably low cost. During the first few years of manufacture the price of aluminium ranged from 90*s.* to 60*s.* per pound, and from 1862 to 1886 the price was 35*s.* to 40*s.* per pound. Soon after the latter date the Aluminium Company, Limited, with works at Oldbury, came into the market with the metal at 20*s.* per pound. The price was soon lowered by the competition of the Alliance Aluminium Company, Limited, with works at Wallsend-on-Tyne. These two companies were soon forced out of the market by the companies at Neuhausen and Pittsburgh, which began selling the metal at about 8*s* per pound, and have since, owing to the larger consumption of the metal and the consequent decreased cost of production, been able so to reduce the selling price that it is now, volume for volume, but little more expensive than copper.

As the many valuable qualities of the metal have led to the belief that the price was the one obstacle to its extensive use, and as the compounds of the metal are found so universally and abundantly in nature, there has been no lack of investigators seeking to reduce aluminium by chemical means, but so far the sodium process has been the only one which would give the desired results. As noted above, it requires 3 tons of sodium for 1 ton of aluminium by either of the sodium processes, so it is easy to see why these processes are unable to compete.

As all clays contain a large percentage of alumina, it is a popular fallacy that aluminium is reduced from clay. The ore used is pure anhydrous alumina, which contains 52.94 per cent. of aluminium, and in practical working less than 2 tons of this material are required for 1 ton of metal, so that the efficiency as regards the ore is perfect.

The development of the electrolytic processes for making aluminium created a demand for pure alumina, and manufacturers have succeeded in supplying an article over 99 per cent. pure, the 1 per cent. being made up principally of water and silica. Pure carbon electrodes were necessary, and these are furnished with a fraction of 1 per cent. of ash. The result is that aluminium is made so that the entire product is over 99 per cent. pure, which is much better than the regular results obtained by the chemical processes. As the methods at present employed consist of the direct reduction of the oxide of the metal, it does not seem possible to have a more simple process, and not probable that a more complicated compound can be treated in a more economical manner. It may be inferred, therefore, that further cheapening of aluminium will depend upon the greater consumption of the metal and also upon cheaper power and materials, and the consequent decrease in the average general expenses with greater output. The present total output of pure aluminium is between 4 and 5 tons per day, which is more than the annual production up to 1886. This rapid increase in production has been due primarily to the decreased selling price, which encouraged consumers to make practical use of the metal. The present consumption may be graded into three classes, each of which takes about equal parts. These are iron and steel, brass and bronze, and pure metal.

The best testimonial is the continued use of the metal, and this is given by both iron and steel makers, and bronze founders. The properties of aluminium have been greatly exaggerated, and as greatly depreciated by many writers whose chief ability seemed to be their desire to appear in print. Notwithstanding the difficulties in perfecting a new process, and in introducing a new metal, aluminium has obtained a place among the metals of ordinary and daily use, and its position is continually being made more secure by a further appreciation of the uses to which it has been put successfully, and by new uses for which it is almost daily being introduced.

In using aluminium for steel the amount varies from one-third to three-quarters of a pound to 1 ton of steel, the result being sound ingots or castings free from blowholes, and a decrease in scrap and wasters. A further advantage is that a milder steel can be used for castings.

Wrought-iron castings have been made by the Mitis process, which depends upon the use of aluminium, but the variable results obtained have not led to the general use of this process, although it has not been abandoned.

The use of aluminium with cast iron produces sharper and cleaner castings, free from blowholes, and gives a more uniform casting. The iron is made softer, with less tendency to chill, part of the combined carbon being converted into graphite.

The amount of aluminium to be added to cast iron varies with the quality of the iron, but 1 to 2 lbs. to the ton of iron

gives good results. Too much aluminium is apt to be worse than none at all, and while it does useful work in cast and wrought iron and steel, its presence in the finished metal is not wanted.

This is not the case with the copper alloys, where aluminium is used to great advantage up to 10 per cent., beyond which the alloy becomes extremely hard and brittle, and loses its valuable qualities.

Aluminium is used with all the well-known brasses and bronzes with beneficial results in quantities up to 1 per cent. for deoxidizing or purifying the mixture, and its presence in the finished product is not detrimental. The result of these small quantities of aluminium is to produce cleaner and stronger castings.

While copper and aluminium alloy in any proportion, the useful bronzes do not contain over 10 per cent. of aluminium. These bronzes vary in strength and physical properties, but all of them can be forged hot or run into sand castings. Castings of 10 per cent. bronze are much like rolled mild steel, having a tensile strength of 26 tons to 28 tons per square inch, and an elongation in 2 in. of 25 per cent. to 30 per cent., but with a specific gravity of 7.5, while steel is 8.0. The 5 per cent. bronze is much softer and less strong, having a tensile strength of 17 tons to 18 tons per square inch, and an elongation of 60 per cent. to 70 per cent. in 2 in. Many different qualities of aluminium brass are made, but the best give a tensile strength from 30 tons to 35 tons per square inch, and 6 per cent. to 15 per cent. in 2 in., as required.

There are no copper alloys without aluminium which approach those containing aluminium, and from the physical properties noted above it will be seen that sand castings can be made equal to wrought-iron forgings, and with a material which is not consigned to an almost valueless scrap heap should an accident occur to the part. Increased tensile strength is obtained in the bronzes by the addition of silicon, but it is at the expense of elongation.

The pure metal is used as such for many different purposes in castings, sheets, tubes and wire. The malleability of the metal is such that it can be beaten into leaf, which has largely replaced silver leaf.

The shrinkage of pure metal is about ¼ in. to the foot, but castings are usually hardened, so as to get increased strength and to allow machining, and the shrinkage decreased.

The pure metal is quite soft, and in castings has a tensile strength of about 8 tons per square inch, while the hardened metal has a tensile strength of about 12 tons per square inch, and is as hard as gun-metal. Sheet and wire are much stronger than castings, depending on the amount of work done on the ingot metal. As no satisfactory solder has been found for aluminium, its uses are restricted to work that can be cast, stamped, spun, drawn or riveted, yet with this drawback the applications are numerous when there is a disposition to use the metal. Aluminium cooking utensils have found favor wherever tried, and are at present supplied by several makers.

The reading of the paper was followed by a short discussion, in the course of which Mr. Joseph Adamson, of Hyde, stated that he had been in correspondence with Captain Hunt, President of the Pittsburgh Reduction Company, with a view to the construction of a boiler of aluminium plates, and from the information he had received, it appears that the company are now producing plates of nearly pure aluminium, having a tensile strength of 50,000 lbs. per square inch, or if necessary 55,000 lbs., an elastic limit of 35,000 lbs., with a reduction of area of 20 per cent., or, in other words, with an elastic limit equal to that of good soft steel, which is three times as heavy. At present the Company are rolling plates up to 30 in. in width, and are prepared to supply ingots at a cost of about 2*s*. a pound, which can be rolled to the same size as ordinary steel boiler plates.

NOTES AND NEWS.

Railway Pension Fund of Holland.—Employés of State railways in Holland pay 1 per cent. of their wages to a pension fund, and during illness they receive two-thirds of their regular salary for four months.

English Dining-Cars.—The Midland Railway Company on trains from London to Glasgow has introduced the American system of dining-cars, but has bettered it by serving meals for both first and third-class passengers. The dinner, first-class, is 85 cents, third-class, 60 cents. Passengers who prefer may dine *a la carte*, ordering a cup of coffee for 5 cents, or tea with bread and butter for 10 cents, or a chop with bread and potatoes for 30 cents.

Railway Trains Run by Water-Power.—The announcement is made that the Canadian Pacific Railroad will adopt the trolley system for moving trains over two sections of the Rocky Mountains. The power will be developed from the waters which rush down the precipices and along the mountain sides.

A 2,000-Volt Electric Current.—Mr. Tesla has been making some brilliant experiments with high-voltage electric currents. It is stated that he has received through his hands currents at a potential of more than 200,000 volts, and there is a report that he expects to obtain a potential of 3,000,000 volts in some of his future experiments.

Rail to the Arctic Ocean.—A plan is on foot in Russia for building a railroad to the Arctic Ocean near the Swedish frontier. Starting from the Norwegian terminus of the Finnish railways, the road will be about 470 miles long. There are no serious engineering difficulties in the way of such a railway, and as it will be built on a cheap system much used in Finland, the cost will be in the neighborhood of $13,000,000.

Windmills for Electrical Lighting.—Some extensive experiments have been made lately with the use of windmills for electrical lighting, which have given promise of ultimately developing into something that will be successful and useful. The records of the United States Signal Service for the past 15 years show that wind may be relied upon to blow with sufficient velocity to drive a windmill with its average working capacity 8 hours out of every 24.

Illuminated Life Buoy.—Some trials have recently been made on board a German war vessel with an electric-light buoy. The buoy was thrown overboard when the vessel was proceeding at a speed of about 16 knots. For a few seconds it was lost in the eddy currents caused by the screws, but then reappeared. It is expected that the buoy will be found useful at night, and the experiments have resulted so successfully that it will probably be adopted by the German Navy.

Felling Trees by Electricity.—Trees are felled by electricity in the great forests of Galicia. For cutting comparatively soft wood the tool is in the form of an auger, which is mounted on a carriage and is moved to and fro and revolved at the same time by a small electric motor. As the cut deepens wedges are inserted to prevent the rift from closing, and when the tree is nearly cut through an ax or hand-saw is used to finish the work. In this way trees are felled very rapidly and with very little labor.

Test of Armor-Plate.—On May 15 there was a test of the armor-plate representing the turrets of the *Maine*, *Puritan*, and *Monadnock*, at the proving ground of the Bethlehem Iron Company. The plate tested was Harveyized and curved as it would go on the ship, with a thickness of 8 in. To cause the acceptance of the armor which it represented, it had to receive a blow from a 100-lb. 6-in. shot at 1,678 ft. per second without cracking, and a blow from another 6-in. shell having a striking velocity of 1,978 ft. per second, without being penetrated. These conditions were met. The penetration by each of the shots was from 2 to 3 in. As the projectiles were broken and the pieces remained welded in the holes, it was impossible to accurately measure the penetration, but the plate was not cracked. Captain Simpson, Chief of the Bureau of Naval Ordnance, who directed the details of the trial, ordered the 18-in. gun fired at the plate with 1,835 ft. velocity. A 250-lb. armor-piercing projectile was fired. The plate was cracked, but not penetrated by this blow.

A Peculiar London Railway Station.—A very queer railway station in London is that at Wapping, on the East London Line. Very few dwellers in other parts of London ever get out at Wapping, and thus they miss the singular beauties of the station. Its appearance is that of a huge caisson for some engineering works to which winding staircases have been added. Up the sides of the huge caisson the passengers crawl like flies on a window pane. The secret of its queer appearance is that it was originally the northern shaft of the famous Thames Tunnel, which Brunel built in 1843 at a cost of £468,000 ($2,277,522). It was very dangerous work, owing to the porous nature of the river bed, and the tunnel was long considered a masterpiece of engineering. It consists of two arched ways of 1,200 ft. long, 14 ft. wide, 16¼ ft. high, and 16 ft. below the river. For a long time it was a popular excursion to go through the tunnel; but it never was a financial success, and in 1865 the East London Railway bought it for £200,000 ($973,300), or less than half its cost. The company now leases its lines to a syndicate of other companies, who use the tunnel as means of communication between the southern and northern railway systems.

A New Austrian Mitrailleuse.—The Austrian Government has definitely adopted Archduke Karl Salvator's automatic mitrailleuse. The arsenal trials proved highly satisfactory. One hundred of the guns have already been manufactured. The gun will not be used in field service, but only on the works of the fortresses. It is about half the weight of the Maxim machine gun, and has about the same firing rate. The barrel is incased in a water jacket. Twelve hundred rounds can be fired continuously without overheating the gun.

The Local Traffic of many roads is curiously managed by some one. It is not unusual to see two and three-car trains run by locomotives of 90,000 lbs. weight, and compound at that. As the mileage made by these engines on local trains is all charged in the annual report, it is not surprising that the compound engine is not so economical as expected. To a train despatcher or a round-house foreman anything is a locomotive, but some one should be in charge who understands the ins and outs of the matter. It is a great waste of power to use a horse to draw a baby-wagon.—*The Engineer.*

Petroleum for Fuel in Buenos Ayres.—Experiments have recently been made, it is said with success, on the Southern Railway of Buenos Ayres, in the use of petroleum on locomotives. Only two conditions are needed to make its use practicable: one is that other fuel relatively to petroleum should be dear, and that petroleum relatively to other fuel should be cheap. Under those conditions petroleum may be used economically, otherwise not.

Aluminium for Lithography.—The latest use to which aluminium is put, notes a technical journal, is in lithography, in which process it is claimed to possess many advantages over the stone now used while fulfilling all the requisite conditions. The only stone used for lithographing is found in Bavaria, and as the supply is diminishing the price is increasing. Moreover, it is very brittle, and being rigid can be used only on flat surfaces. Under a recently patented process, we are told, aluminium plates can be molded into forms for cylinder presses.

The First Iron Bridge.—The first iron bridge ever erected in the world, and which is in constant use at the present time, spans a little river in the county of Salop, on the railroad leading from Shrewsbury to Worcester, England. It was built in the year 1778, and is exactly 96 ft. in length. Total amount of iron used in construction, 378 tons. Stephenson, the great engineer, in writing concerning it, said: "When we consider the fact that the casting of iron was at that time in its infancy, we are convinced that unblushing audacity alone could conceive and carry into execution such an undertaking."—*St. Louis Republic.*

The Lake Steamer "North America."—A new steamer has recently been launched at the Globe Iron Works, Cleveland, for the Northern Steamship Company, and it is intended for service between Duluth and Buffalo. The general dimensions are as follows: Length over all, 383 ft.; length between perpendiculars, 360 ft.; breadth, molded, 44 ft.; depth, 26 ft.; depth to spar-deck, 34 ft. 5 in. The vessel has been built of mild steel throughout, with an inner bottom extending from the collision bulkhead forward to the afterpeak bulkhead aft. It has been built under special survey in order to obtain the highest classification in the United States standard rules.

This vessel is fitted with two vertical quadruple-expansion engines of 3,500 H.P. each, and with a total H.P. of 7,000 the vessel is expected to make an average speed of over 20 statute miles per hour. The boilers are the Belleville patent water-tube system; their nominal evaporative efficiency will give the main engines 7,000 H.P. and to the auxiliaries 500 H.P. more, with natural draft.

The electric-lighting plant is divided into three units; each unit consisting of a vertical, direct-connected, three-cylinder, triple-expansion engine and dynamo. The units are of 400—16 c. p. light capacity each, and develop an E. M. F. of 110 volts at 300 revolutions per minute. The state-rooms are lighted by 16 c. p. lamps, enclosed in ground glass globes; these lamps are lighted and extinguished by a switch placed adjacent to the berth. The main saloon is lighted by means of beautiful clusters, and in each panel running parallel with the state-rooms is placed a 16 c. p. lamp, enclosed in a ground glass globe. This same mode of lighting is followed in other departments; the style of fixtures, however, is somewhat varied.

A refrigerating apparatus will be supplied by the De La Vergne Refrigerating Machine Company, of New York. The machine which this Company supplies will be one of 8 tons refrigerating capacity every 24 hours, and is the model which this Company has especially designed for the purpose of going on board of ships.

Russian Armored Ship "Navarin."—The new Russian armored ship *Navarin*, launched in 1892 (but formally commenced October 8, 1890, in the anniversary of the famous Navarin sea battle), is now incorporated to the Russian fleet, and will have a crew of 579 men. The *Navarin* is, the *Peter the Great* being excluded, the largest ship in the Baltic fleet. The general dimensions are: Length, 338 ft.; breadth with armor-plates, 67 ft.; draft, 25 ft.; displacement, 9,476 tons. The whole ship is made of steel, the over deck (armored) also; only the planking of the overdeck and the lining of the armor are of wood. The armor extends 3 ft. above the water-line and 4 ft. below it. The thickness of armor in the middle part of the ship is 16 in.; the thickness of armored turrets is 12 in. There are two engines of 9,000 indicated H.P. Each engine has a counting apparatus and another apparatus which show the number of revolutions of the screws. The engines are provided with 12 cylindrical boilers, each with three furnaces. The ship has a steam winch and special vertical tubes for hoisting ashes from the ash-pits; and a steam steering-gear. Each engine contains a special evaporator to produce 2,200 galls. of water for boilers, and 1,900 gallons of fresh drinking-water a day. Each evaporator is provided with two apparatus of Totov, which gives 160 galls. of fresh water in an hour. The ventilation is very perfect. The military department has its own ventilation. The ship will be lighted by electricity. The auxiliary means of transport consists of two rowing long-boats, one half long-boat, two transport boats, two six-row-yawls, two steam long-boats; eleven in all. There is a single mast, very thick, of steel, only for giving signals. It has two side shrouds for hoisting the long-boats. Aloft the mast is armed with 10 rapid-fire guns. The armament consists of four giant 12 in. guns in two turrets, which are revolving and each contains two guns. They are the largest guns which have yet been made for the fortresses. Beside them the ship has eight 6-in. long-shot guns in the middle part, four each side; 12 rapid-fire guns on the stern, fore and middle, and 10 guns on the mas (as above said); and six Whitehead mining (torpedo) apparatus. Under this armed part of the ship the sailors' deck is placed. The captain's cabin takes its stern end (three rooms); the ward-room, bath, and bar are also situated here. The officers' ward-room and their cabins (state-rooms) are nearer to the center. Below this deck, and therefore, already under water, the rooms for the crew are designed. The armored ship *Navarin* was built by the Company of Franco-Russian Works in St. Petersburg. The hull alone cost $800,000. The engine was also made by the same Company, and cost $724,200, and with supplementary devices and evaporators, $770,800. Therefore the whole cost of the ship is $1,570,800. For comparison we will say that the armored ship *Peter the Great* has cost $3,000,000. The ship is not yet finished, and now she has gone from Newa Channel (in St. Petersburg) to Kronstadt, where she will receive the armament, and next year she will make a four months' cruise.

Underground Traction.—It is reported that the Metropolitan Traction Company, of New York, are to make a trial of the Siemans-Holske system of underground electric trolley line in New York. The system has been in use successfully for some time in Buda-Pesth on several lines, the first of which was laid down in July, 1889. This system is of the simplest construction, consisting of a conduit of pear-shaped section with two angle irons on one side, one for the in-going and the other for the return current. Sliding contact is made by means of shuttle-shaped sliders. Sixty cars are now run over the lines at Buda-Pesth, at an average speed of 12 miles an hour, and at a cost of 5¼ cents per car mile. It would thus seem that this system has demonstrated its practicability at Buda-Pesth, and it remains to be seen if the conditions at New York would militate against its success there. It may be noted that in a report of the United States Consul at Buda-Pesth, made about a year ago, it was stated that the operation of the road was several times interrupted by unusually heavy falls of snow, though otherwise its operation was declared successful.

Spray in the Boiler.—A French engineer is reported to have designed a safety boiler of a somewhat novel character. It consists of a nest of horizontal tubes placed over the furnace. Into this nest water is injected in the form of spray, under which conditions it is instantaneously evaporated and superheated. "Solid" water, if one may use the term, is never admitted to the tubes. The evaporative power of the boiler is said to be remarkable, and it is stated that the tubes do not burn out.

Cost of Transmitting Power.—A comparison of the cost of transmitting power by various methods, as given in a French mining journal, presents the following data: 1. Comparative cost on 10 H.P. transmitted in 1,093 yds.—by cables,

1.77 per effective H.P. per hour; by electricity, 2.21; by hydraulics, 2.90; by compressed air, 2.98. 2. Comparative cost on 50 H.P. transmitted 1,093 yds.—by cables, 1.35 per effective H.P. per hour; by hydraulics, 1.87; by electricity, 2.07; by compressed air, 2.29. 3. Comparative cost on 10 effective H.P. transmitted 5,465 yds.—by electricity, 2.64 per effective H.P. per hour; by compressed air, 4.66; by cable, 4.69; by hydraulics, 5.29. 4. Comparative cost on 50 effective H.P. transmitted 5,465 yds.—by electricity, 2.34 per effective H.P. per hour; by cables, 2.65; by compressed air, 2.99; by hydraulics, 3.02. Steam was the prime mover used in each of the above instances, and it appears that, for long distances, electricity takes the lead in economy over all other systems. It has also, remarks the journal cited, a great advantage in the facility with which the power may be subdivided, and there appears to be no doubt that, in future coal mining, electricity will be much used for coal cutting, tunneling, pumping, hauling, etc.

The "Ericsson."—Considerable interest has been excited from the fact that a new torpedo boat, the *Ericsson*, was launched at Dubuque, 1,500 miles from the ocean. The designs for the hull and machinery and armament of this boat is 154 ft.; beam, 15½ ft.; draft, 4¾ ft. Her displacement, normal, is 100 tons. She was designed to be longer and broader than the *Cushing*, without drawing so much water, and giving a greater speed. Completed, with slight changes in the design originally adopted, the *Ericsson* will compare with the *Cushing* as follows:

Ericsson: Length, 154 ft.; width, 15½ ft.; draft, 4¾ ft.; indicated H.P., 2,500; 24 knots speed; displacement, 150 tons.

Cushing: Length, 138 ft.; width, 15 ft.; draft, 5¼ ft.; 1,720 H.P.; 22 knots speed; displacement, 116 tons.

The general construction of the vessel is on the transverse system, and special attention has been given to the longitudinal strength and stiffness by the use of an intercostal vertical keel and broad, heavy stringer plates. At the bow a turtle-back deck works into and terminates in the conning tower. The armament of the vessel will consist of one fixed tube in the bow for firing the Howell torpedo; two diverging tubes on a training circle aft for the firing of the Whitehead torpedo, and four 1-pdr. rapid-firing guns. The turtle-back deck is also worked in a way to accommodate the torpedo tube and loading gear in the bow.

In the interior the boat is thoroughly modern, and that, of course, signifies something novel in a United States torpedo boat. The motive power was designed by the Bureau of Steam Engineering, and consists of two propelling engines (rights and lefts) of the vertical, inverted, direct-acting, quadruple-expansion type, with Thornycroft boilers, all placed in a common water-tight compartment. These are calculated to give a speed to the vessel of about 23 knots working at 412 revolutions a minute, and under a steam pressure of 250 lbs. to the square inch. The weight of all machinery, boilers, auxiliaries, and contained water, but exclusive of all stores, spare parts, steering-gear and capstan, is less than 52 tons. An electric plant for lighting the vessel by the incandescent system and for operating a search light has been provided. This plant is installed in the engine-room. Every means for the comfort of the officers and crew in the cramped quarters allotted to them has been employed, the fact being borne in mind that the radius of action of a torpedo boat is limited rather by the endurance of the people on board of her than by the amount of coal carried in the bunker. Two state-rooms are provided for the officers, and a large room, extending the entire width of the boat, containing four bunks, is provided for the petty officers. In the crew's quarters there are 12 bunks and a swinging space for four hammocks.

To make the special character of the *Ericsson* plain, a comparison with some of the latest built torpedo boats of the British and French navies is herewith given.

Vessels.	Length.	Displacement.	Speed.
Ericsson, U. S.	154 ft.	150 tons	24 knots.
Havock, H. M. S.	180 "	110 "	27 "
Conreur, France	149 "	114 "	23.5 "

Each one of these boats is intended to carry three quick-firing guns and to discharge torpedoes ahead and astern, or in practically any direction. It may be stated that of these three boats the *Conreur* is the only one now in commission.—*Providence Sunday Journal.*

Purdue University Laboratory.—President Smart, of Purdue University, has sent out a circular in which he announces the present state of affairs regarding the restoration of the laboratory which was burned on the 23d of January last. The announcement is made that the portion of the buildings which contained the foundry and wood-working shop has been repaired, and that the machines and tools are now in use by students. The machine-room, forge-room and steam engineering laboratory are in process of reconstruction. That portion of the plant which has excited the greatest interest among the railroad and engineering fraternity is the locomotive plant for testing locomotives, and every one will be glad to learn that this will not only be replaced, but that the facilities for doing work will be very greatly increased. This plant will be removed from the general laboratory to a new building especially designed to receive it, and the new plant will be larger and more complete than the original. Its parts will be made adjustable to receive any locomotive whatever; and in order that the whole may be available for testing the performances of locomotives from any part of the country, the building will be connected by a track with the Lake Erie & Western Railroad. A new traction dynamometer made up of the weighing portion of an Emery testing machine of 30,000 lbs. capacity has been especially designed, and is now being built by Messrs. William Sellers & Company. The possession of this fine piece of apparatus will secure great accuracy in the determination of draw-bar stresses, which is one of the important elements in the performance of a locomotive. The importance of the locomotive work that originated at Purdue has been especially recognized. Before the fire there was a single locomotive; now, by the addition of the Baldwin working model, there will be in effect two; then the locomotive was in the general laboratory, now it is to occupy an annex by itself; then it was an isolated plant remote from railroads, now the annex is in track connection with the railroads of the country; then the plant was arranged to test the Purdue locomotive *Schenectady* only, now ample provision has been made for testing any locomotive that may be ordered. Certainly the officers and faculty of Purdue University are to be congratulated upon the prompt response for assistance which they have received and the cheerfulness with which large sums of money have been made available for the restoration of this most valuable laboratory.

Projected Line up the Jungfrau.—The Swiss Department of Finance has received from the well-known financier of Zurich, Guyler Zeller, a request for the concession for a road of a new design up the Jungfrau. We know that there are already three old projects in existence at which the point of departure is put in the upper valley of the Lauterbrunner. The others are Messrs. Coechlin, formerly Engineer of the Eiffel establishment in Paris; Colonel Locher, and Engineer Trautweiller, but up to the present time none of these projects have any chance of being executed. The new project will start from Scherdegg Station, which is the highest point reached from the railroad Wengeralp that was opened to traffic in 1893. Starting from Scherdegg, the route turns to the west, passes along the side of Fallboden, and abuts directly at the foot of the Eiger glacier, then toward the east and afterward to the south into a tunnel, in order to avoid the massive Eiger, and reaches Eiger Station, located at an altitude of 10,171 ft., and is built in under open cut. Then the line turns to the right, still in the tunnel, toward Moench and the neck of the Jungfrau, which will be pierced at a distance of 345 ft. from the crest; it then turns in a spiral up through the massive rock of the Jungfrau itself to emerge on a small plateau located 4,593 ft. above the level of the sea. This plateau is 213¼ ft. from the summit, and is not covered with snow in the summer-time. Finally, the crest is reached by means of an elevator of 213¼ ft. in height, composed of two concentric tubes of iron; the interior to be enclosed. The elevator proper and the annular space between them is provided with a stairway. At the center of the line between Scherdegg and Eiger stations, as well as between Eiger and the Jungfrau, stopping and crossing places are located. The gauge of the track is to be 2 ft. 7½ in. The minimum radius of curves will be 197 ft. and the steepest grade will be 25 per cent. The line in the open will have a length of 7,054 ft., the tunnels, 33,629 ft.; curves represent 26 per cent. of the total length of line. In variations from this project the figures given above are respectively 820 ft., 27,560 ft., and the total length is 6.77 miles instead of 7.7 miles of the original project. As for motive power, they propose to use electricity. The tunnels are to be lighted with electric light; their section will be 129 sq. ft. The water power will be taken at Tunnelbach or at one of the two Lutschines. The line will first be built up to Eiger station, and this will necessitate further service and a delay of two years. During the following two years the second section of the line will be built. The estimated outlay is, for the main line, $1,425,000 in round numbers, of which $972,040 is for substructure, $71,820 for superstructure, and $115,900 for rolling stock from the elevator for the State lines; the cost of construction will rise to $1,254,000, and an estimated dividend is placed at 5.16 per cent.

Cotton Mills in Egypt.—The success which has attended the establishment of mills in the United States and other countries in the neighborhood of cotton fields has suggested to capitalists the practicability of trying the experiment in Egypt of fabricating the native cotton to clothe the people of the country. A company is forming with English and local capital to establish at Cairo a factory of about 18,000 ring spindles and 500 looms of the newest and most approved make; and if the venture prospers it is proposed to establish mills at Alexandria and other points. The Cairo factory will be under English management, and will be equal in many respects, it is promised, to the most modern and best-equipped factories in England. An authorization for the undertaking has been granted by the Egyptian Government, and assurances have been given that every encouragement will be afforded the new industry. The demand for cotton cloth in Egypt is large and constantly increasing, while Cairo is a distributing point not only for Upper and Lower Egypt, but also for the supply of cotton goods to the adjacent countries. Egyptian cotton, both brown and white, is well known to be of excellent quality, and can be delivered in Cairo at a much lower price than in England; the rate of wages is also much lower. The Egyptian workmen are clever and easily taught, and the supply of suitable labor is ample. In addition to the cost of freight and forwarding expenses on all goods coming into Egypt from Europe, there is a duty of about 8 per cent. ad valorem payable on all imported goods. These charges will be saved on the home-made production as well as the original 1 per cent. paid on the cotton when it was shipped from Egypt. This saving, coupled with the suitability of the climate and the abundance of good labor, furnishes evidence of the practicability of the undertaking. The site of the proposed factory is in the immediate vicinity of the Nile, whence water for all purposes will be obtained, and the river can also be used for the conveyance of coal and cotton to the mill. A railway runs near the factory, and a branch line of rails can be extended into the grounds, thus giving direct communication with all the railways in the country. With a population of between 7,000,000 and 8,000,000 people, in a climate where garments of wool are worn but a few months in the year, the project theoretically has much to commend it; and with intelligent and prudent management this venture may be the precursor of a movement that will make the people of Egypt independent of England for their fabrics, for Manchester's looms now supply more than 90 per cent. of the textiles coming into the country. The enterprise should render its projectors a fair measure of profit and at the same time give the Egyptians the advantage of a saving in the cost of their clothing, and illustrate for the benefit of other nations whether Egypt offers a medium for the profitable employment of capital in cotton working.—*Consular Reports.*

An Ancient Telephone.—It is a pretty widely known fact that as early as 1667 the English physicist, Robert Hooke, described the transmission of sound to a very considerable distance. He says that, by the help of a tightly-drawn wire, which even might be bent in many angles, sound might be propagated to a long distance, and with a rapidity which, though inferior to that of light, was, at any rate, infinitely superior to that of sound in the open air. It is a most curious fact, and one which is not so generally known, that Jacob Christoph Von Grimmelshausen, a German author of the seventeenth century, in the first chapter of the third book of his celebrated novel, "Simplicius Simplicissimus," mentions an instrument which, according to his description, not only corresponds to Robert Hooke's apparatus, but leads to the assumption of the existence of a contrivance at the time of the Thirty Years' War very similar to our present telephone. The passage from the book reads literally as follows: "I was, as already mentioned, so eager to gain honor and renown, that I could not sleep while all this was passing through my head. And when I had such fancies, and lay awake many a night thinking how I might contrive new finds and stratagems, I had very curious notions; consequently I bethought myself of an instrument with which I could on a calm night hear a trumpet being blown at three hours' distance, and a horse neighing and a dog barking at two hours', and a man talking at one hour's distance. In the daytime the instrument was not so useful to me unless it were in a quiet place, because one would have heard the horses and the cattle down to the least bird in the air, or frog in the water, all together, so that one would not have understood one in consequence of the noise of the other. Now, I know quite well that there are people at this very hour who do not believe me; but, whether they believe me or not, it is the truth. I undertake, by means of an instrument invented by me, to recognize at night by his voice a man who does not speak louder than his usual custom. And no one would believe me of those who saw with their own eyes how I used the aforesaid instrument, and when I said to them, 'I hear horsemen galloping, for the horses are shod,' or 'I hear peasants, for the men go barefooted'; then, 'there goes a herd of cattle, for I hear sheep bleating, bulls bellowing, and pigs grunting, and so forth.' My own comrades at first took these speeches for 'fibs,' but when they found in reality that I was always speaking the truth, then they called it witchcraft taught me secretly by the devil's own mother. I am of opinion that if I had taught this science openly I should have become very popular, because it would have proved of great advantage to those engaged in war, especially in sieges." This is what Grimmelshausen says about his "far-hearing instrument," to which must be accredited a certain resemblance with the present telephone.—*Machinery.*

Engineering Feat at Holloway.—In the ordinary performance of the daily work at a terminal station the coaches which arrive from their journeys have to be stored, cleaned and transferred from the arrival side to the departure side of the station. At King's Cross the Great Northern Railway has always done some of this work in the terminus itself, but the recent erection within it of two additional platforms for main lines service has necessitated an entirely new storage ground at Holloway. The empty coaches will be run up to it by an extra line of railway, but between the site itself and the line of rails by which the coaches have to be returned to King's Cross there are eight intervening roads of main line, for goods and slow and fast passenger service, upon which the traffic is so busy that, between midnight of one day and midnight of the next day, there is only one free time of a quarter hour—namely, between 1.15 A.M. and 1.30 A.M.—when anything could pass across without interruption from one side of the railway to the other. Nothing could be done on the surface without extreme danger, and nothing at all in a fog. To construct a passage under the eight main lines had, therefore, to be done under circumstances which have no actual parallel. The Canonbury Railway has for years dived under the Great Northern at this point, and another subway has now been made alongside of it under the eight main lines referred to.

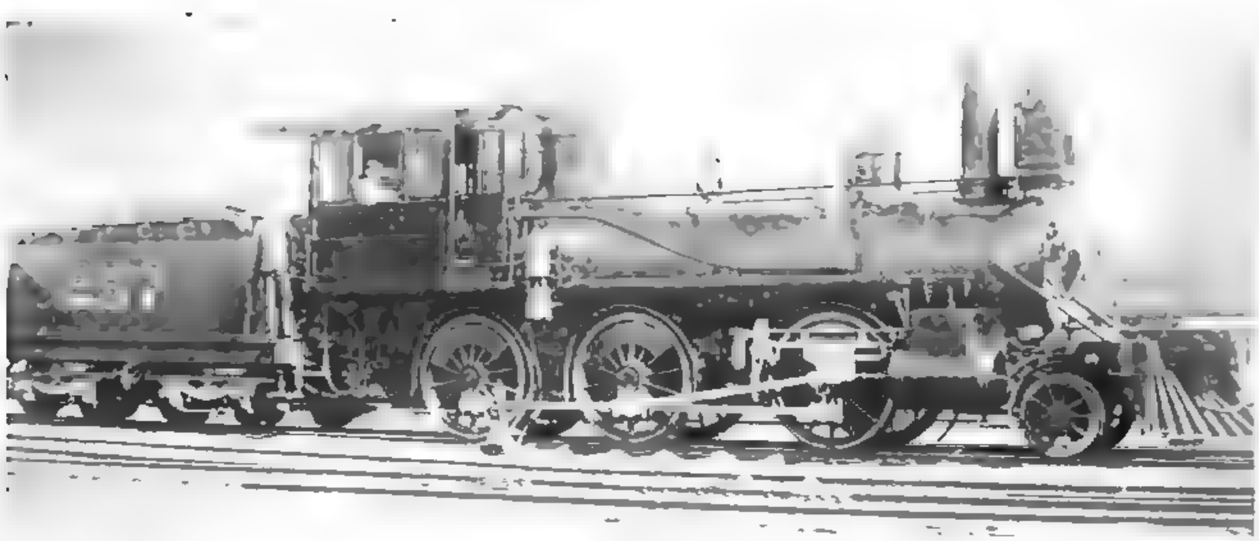
The problem was how to effect this without any disturbance of the service runnings of the trains. First the eight double lines of rails were temporarily secured by timbers put under them—a roofing being thus formed for excavating a working trench below. The abutment wall of the Canonbury Railway was next strengthened, and at the required distance away from it a second wall was built underground. On the east side of the main lines was a shunting-ground with numerous points and crossings. This constituted the *crux* of the undertaking, because only in the intervals of the cessation of traffic on Sundays could this tract be cleared and the rails replaced. Steps were accordingly taken by erecting at the side of the railway embankment a staging of piles upon which the whole main portion of the new steel skew-bridge—105 ft. long and 26 ft. wide, with end girders on the skew 60 ft. in span—could be riveted up and completely framed together. On each side of the staging was laid a double line of rails, and on each of them was made up a train of four six-wheeled trolleys, kept at distances of 35 ft. apart by horizontal struts of timber. Each of these trolleys was fitted with two hydraulic presses, the rams of which were raised up to the point, so that the under side of the two lateral girders of the bridge, as they rested upon the rams, would be a few inches above the tops of the two abutment walls, which were ultimately to carry this portion of the bridge. When all was completed, three crab-winches were attached to the ropes and pulleys, and worked by four men each. The bridge section, weighing 200 tons, was thus moved slowly forward, the rails and crossings being pulled up and the ground dug out for about 3 ft. in depth before it. Thus a way was cleared for the bridge, which is a flat box-girder construction about 2 ft. thick, to pass onward. When the steel structure had been brought to its final position, the hydraulic rams were lowered until the bridge rested firmly and permanently on the two subterranean abutments. The trains of trolleys were then withdrawn back to the timber staging to be dismantled and removed. The core of earth, or "dumpling," which remains has to be removed at leisure, and then the new line will be free for the service of the empty coaches. In both the structural arrangements and in the moving of the ponderous mass the intricacy of the skew form was intensified by its being also on the curve; but, notwithstanding the difficulties of construction and of moving into place, the designs had been so accurate, and the working to span so true, that the massive structure was brought without any adjustment into a perfect fit with the contiguous line of roadway. To fulfill the whole engagement, eight smaller sections of the bridge were required to be

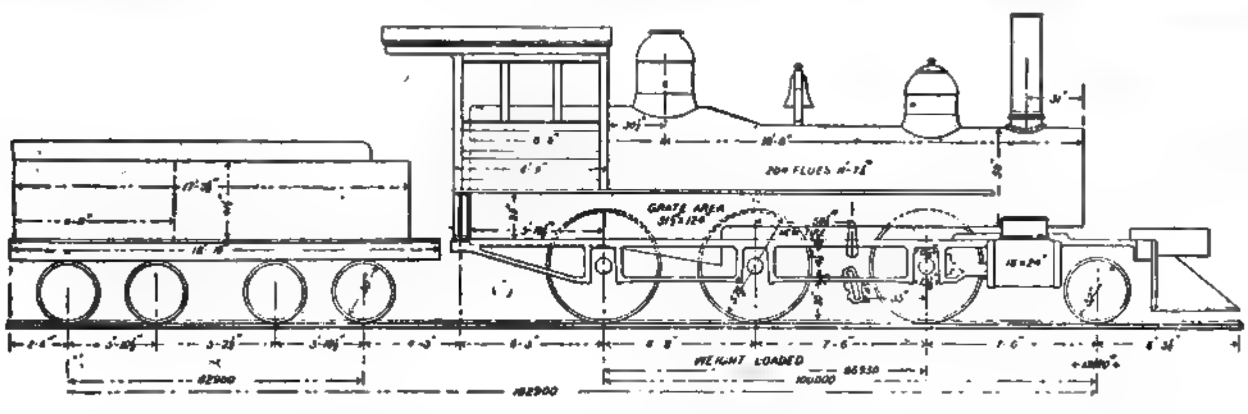
put together on the west side of the Great Northern Embankment, and to be hauled over the main lines into position on succeeding Sundays.—*Indian Engineering.*

STANDARD MOGUL FREIGHT LOCOMOTIVE OF THE DELAWARE & HUDSON CANAL COMPANY.

The Delaware & Hudson Canal Company have a number of mogul locomotives that have been built at the Oneonta shops under the direction of Mr. R. C. Blackall, Superintendent of Machinery, that are doing most excellent service, engravings of which are shown in this connection. Some of these engines have been in service for three years, and have not been in the shops since they were built. They are rated as first-class freight moguls, but have been used on some of the fastest passenger trains, and where, in many places on the road, it is necessary to run at the rate of 60 miles per hour in order to maintain schedule time. This engine, No. 257, has never yet failed to meet the requirements. The freight locomotives on this road are loaded very heavily, so much so that they have to be run "down in the corner" in order to get over the road, and the motive-power department naturally feel that when an engine can be kept out of shop for three years under such treatment as this it is well built. The following are the principal dimensions of the engine :

Kind of fuel used	Anthracite coal.
Gauge of road	4' 8½"
Total weight of locomotive in working order, including two men, actual weight	100,800 lbs.
Weight of loaded engine and tender	158,000 "
Total weight on driving-wheels	86,930 "
" wheel base	21' 8½"
Distance between center of front and back driving-wheels	14' 2"
" from center of main driving-wheels to center of cylinders	11' 10"
Distance from center of main driving-wheels to center of back driving-wheels	6' 8"
Length of main connecting-rod from center to centre of journals	7' 6¾"
Transverse distance from the center of one cylinder to the center of the other	6' 10½"
Diameter of cylinder and stroke of piston	18" × 24"
Horizontal thickness of piston over piston-head and follower plate	5½"
Kind of piston packing	Cast-iron rings.
Diameter of piston-rod	3"
Size of steam-port	1½" × 16" — 1" bridge in center of port.
" " exhaust port	3½" × 16" — 1" bridge in center of port.
Greatest travel of slide valves	5½"
Outside lap of valve	⅝"
Inside lap of slide valves	Line and line
Lead of slide valves in full stroke	1/16"
Throw of upper end of reverse lever from full gear forward to full gear backward, measured on the chord of the arc of its throw	54½"





STANDARD MOGUL FREIGHT ENGINE OF THE DELAWARE & HUDSON CANAL COMPANY'S RAILROAD.

Sectional area of opening in each steam-pipe connected with cylinders	14.18"
Diameter of driving-wheels outside of tires	57⅛"
" " " centers	50"
" " front truck-wheels	33"
Thickness of driving-wheel tires	3⅛"
Size of main driving-axle journal, diameter and length	7" × 9"
" " other " " " " "	7" × 9½"
" " truck axle journals, diameter and length	5" × 9"
" " main crank-pin journals, diameter and length	4" × 4"
" " coupling-rod journals, diameter and length, front and back	3¾" × 3"
Size of coupling-rod journals, diameter and length, main	3" × 4½"
Length of driving-springs, measured from center to center of hangers	39"
Description of boiler	Wagon top.
Inside diameter of smallest boiler ring	50"
Outside " " " " sheet	51"
Driving-wheel base	14' 1¼"
Height from rail to top of stack	14' 4"
Material of barrel of boiler	Otis steel.
Thickness of plates in barrel of boiler	7/16"
Kind of horizontal seams	Double riveted lap with welt.
" " circumferential seams	Double riveted lapped.

Material of tubes	Iron.
Number of tubes	206
Diameter of tubes, outside	2"
Distance between center of tubes	2¾"
Length of tubes over tube plates	11' 9¼"
" " fire-box, bottom	124"
" " " top	128"
Width " " bottom	32"
" " " top	42½"
Depth " " back end	48"
" " " front end	60"
Water space, side of fire-box	3½"
" " back of fire-box	3½"
" " front of fire-box	3½"
Material of outside shell of fire-box	Otis steel.
Thickness of plates of outside shell of fire-box	$\frac{5}{16}$"
Material of inside fire-box	Otis steel.
Thickness of plates inside of fire-box	⅜" sides.
" " " back end of fire-box	$\frac{5}{16}$"
" " crown-plate	⅜"
Material of tube-plates	Otis steel.
Thickness of front tube-plates	⅝"
" " back tube-plates	$\frac{9}{16}$"
How crown-plate is stayed	Riveted to crown bars.
Diameter of dome	27½" inside.
Height of dome	25"
Maximum working pressure per sq. in.	145
Kind of grate	Water grate of 2" tubing, extra heavy.
Width of bars (or diameter of tubes of water grates) out.	2"
" " " " " " " " " " inside	1¾"
" " opening between bars (or tubes)	1"
Grate surface	27½ sq. ft.
Heating surface in fire-box	129 "
" " of the inside of tubes	190 "
Total heating surface	319 "
Kind of blast nozzle, single or double	Double.
Diameter of blast nozzle	2⅜"
Smallest inside diameter of chimney	16"
Height from top of rails to top of chimney	13' 7"
" " " " " " center of boiler	6' 8"
Weight of tender empty	35,700 lbs.
Number of wheels under tender	8
Diameter of tender-wheels	30"
Size of journals of tender axles, diameter and length	3¾" × 7"
Total wheel-base of tender	12' 11½"
Distance from center to center of truck wheels of tender	3' 10½"
" " " " " " tender truck	9' 1"
Water capacity of tank (in gallons of 231 cu. in.)	3,300 galls.
Coal capacity of tender or fuel-bin	5½ tons.
Total wheel-base of engine and tender	45' 3"
" length of engine and tender over all	55'
Thickness of frames	4"
Width over frames	4' 2⅝"
Length of parallel rod, center to center, front	90"
" " " " " " " back	91¾"
Throw of eccentric	5"
Radius of links	50½"

THE RECIPROCATING PARTS OF A LOCOMOTIVE.

By F. J. Cole, Mechanical Engineer, Baltimore & Ohio Railroad.

(*Continued from page 204.*)

The influence of the weight and velocity of the reciprocating parts in a high-speed engine has much to do with its steadiness of motion. The uneven force exerted on the crank-pin, caused by cutting off steam at high pressure early in the stroke, is largely corrected and made uniform by the acceleration required at the commencement of and retardation at the latter part of the stroke.

The subject can be best considered by plotting the curves of variation of tractive force upon the same diagram, on which the curves of fluctuation in weights borne by the driving-wheels, caused by the vertical influence of the counterweight, are shown.

In considering this subject it is first necessary to consider the relation that the movement of the piston bears to the circumferential velocity of the crank. Twice in one revolution the piston comes to a state of rest, on passing a dead center, and equals, about the middle of the stroke, the velocity of the crank, which it is assumed is revolving with a uniform motion. During the first part of the stroke the piston acquires an accelerated velocity, until it reaches the middle, when it moves at the same speed as the crank, and then gradually diminishes until the dead center is reached, after a movement of 180°.

"In order to produce the acceleration, pressure must be applied during the first half of the stroke, and the necessity of bringing the reciprocating parts to a state of rest causes the same amount of pressure to reappear during the second half of the stroke in corresponding ratios upon the crank-pin." *

The pressure required to accelerate the reciprocating parts equals, when the crank is on the dead center, the entire centrifugal force, and gradually diminishes until at the middle of the stroke it becomes zero, being a minus quantity to be deducted from the force applied by the steam to the piston.

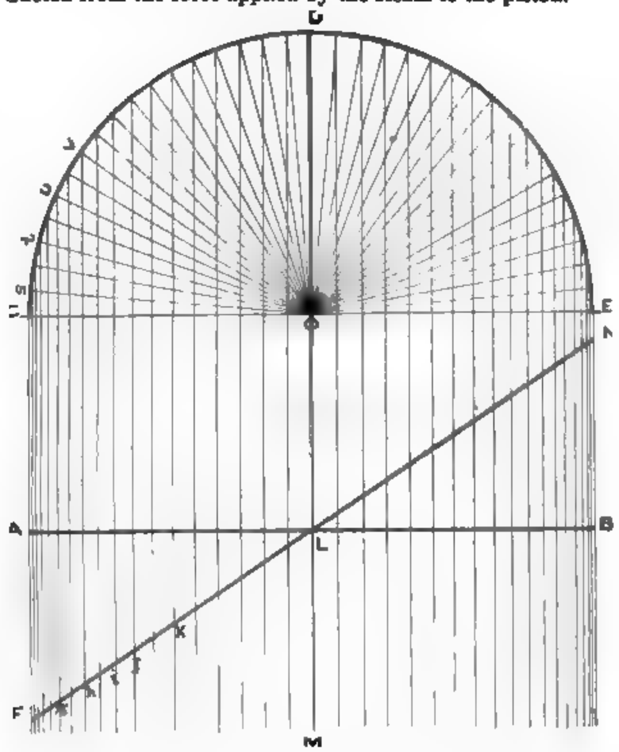


FIG. 11

During the remainder of the stroke, owing to the retardation of piston speed, the same force is gradually given out until it equals again at dead center the centrifugal force, being a plus quantity to be added to the steam pressure.

If the force required for acceleration be calculated for the different crank angles, assuming the connecting-rod to be of infinite length and the pressures marked off on vertical lines corresponding to the different positions of crank, it will be found by joining all these points that a straight line is produced.

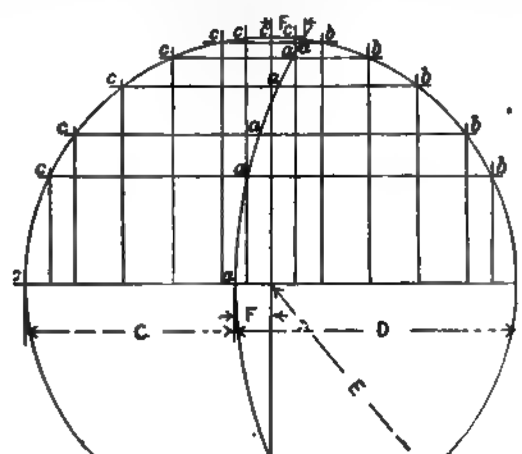


Fig. 12.

Make the line *A B*, fig. 11, equal the piston stroke, and *C D E* the path of the crank, *s t u v*, etc., the crank angles. With the same scale as the indicator diagram make *F* equal, at the commencement of the stroke, to the entire centrifugal force of the reciprocating parts, divided by the area of the piston $\frac{\text{Cent. } F}{\text{area piston}}$. *L*, the middle of stroke, where the speed of

* Arthur Rigg, "Treatise on the Steam Engine."

piston equals the circumferential velocity of crank (no force is absorbed or given out), is located at the intersection of *A B* and *L D*.

N B equals *A F*, for the reason that the force absorbed at the commencement of stroke at *A F* exactly reappears again on bringing the piston, etc., to a state of rest.

The positions for the intermediate crank angles can be found by multiplying the entire centrifugal force divided by the area

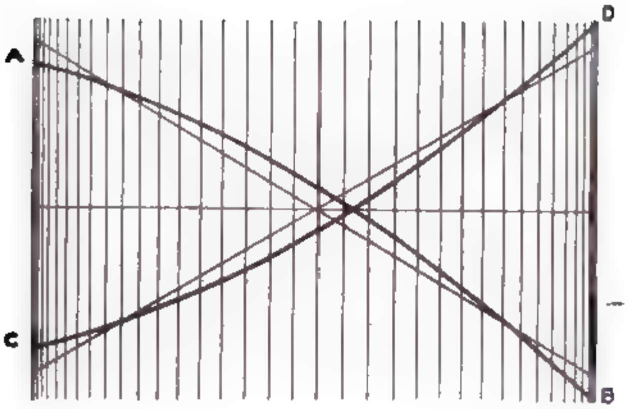


Fig. 13

of piston by the *cosine* of the crank angle. Joining *F g h i J K*, etc., the straight line *F N* is produced, giving at any position of piston the amount measured from the line *A B* to be subtracted or added to the steam pressure on piston. Or if *C O* equals, by any convenient scale, the acceleration required at the commencement of the stroke, the horizontal distance between any of the vertical lines, *g h i J K*, and the center line *O* will equal the force required for acceleration at that position of crank.

It is, therefore, only necessary, in calculating the amount of acceleration required with a rod of infinite length, to make the positions *F* and *N* equal to the entire acceleration required, and joining the same by a straight, diagonal line to obtain the

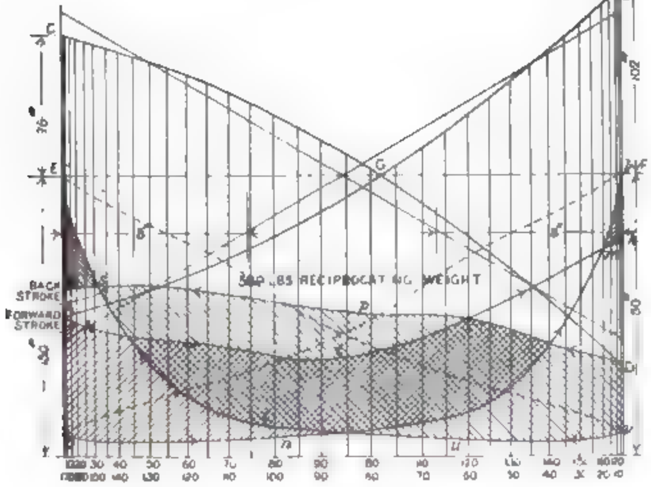


Fig. 14.

amount required at any position of the stroke. In practice, however, as the disturbing influence caused by a connecting-rod of finite length must be considered, the vertical straight line *D O*, fig. 11, becomes a curved line, varying according to the ratio existing between the length of the rod and the crank.

Make the radius *E*, fig. 12, equal on the same scale as the indicator diagram, the acceleration required at the commencement of the stroke, and divide by the vertical lines into 10 equal spaces, the two end spaces in each side being subdivided. Join these perpendicular by horizontal lines, where they intersect the circumference at the points *c c c* and *b b b*. Make *F* at the center line and the top and bottom of circle equal the total acceleration required divided by the ratio of main rod to crank. Find a radius that will intersect the three points thus found, and use it, instead of the straight line *D O*, fig. 11, from which to measure the ordinates.

The force required for reciprocation at any point of the stroke can be accurately determined, and the disturbing influence caused by a main rod of some given length, by the construction of a diagram similar to fig. 13. The ordinates just found in fig. 12 are measured off and plotted on corresponding vertical lines in fig. 13. These points when joined will produce parabolas *A B* and *C D*.

Having considered the manner of constructing the diagrams representing the force absorbed or given out at different points of the stroke, it will be necessary now to show their relation to the indicator diagram, under different conditions, weight

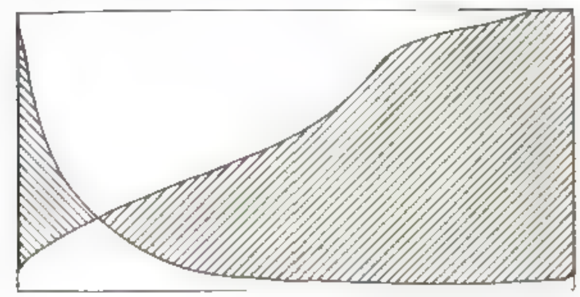


Fig. 15

of reciprocating parts, and speed. Fig. 14 shows an indicator diagram taken from the same class of engine previously used as illustrating the vertical effect of counterbalance on the track. Speed, 60 miles per hour; boiler pressure, 160 lbs.: cut-off, 8 in., or one-third of stroke; length of main rod, $85\frac{1}{16}$ in. The upper dotted lines represent the uncorrected card as it leaves the indicator. Weight of reciprocating parts, 589 lbs., which are the actual weights now in service on the engine.

In order to obtain a clear understanding of the diagram, it is first necessary to imagine the indicator card as it really exists and not as it is usually shown, in which each card for front or back ends of cylinder represents the varying pressure for that end and not the actual thrust on the piston, which is the steam line of one end, combined with the exhaust and back pressure of the other, as shown in fig. 15. A diagram of this

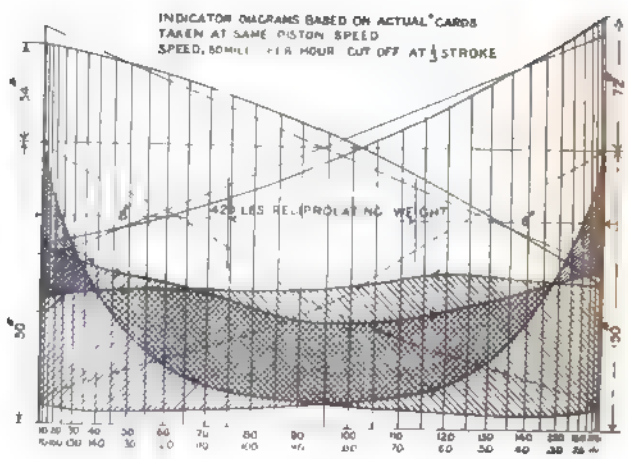


Fig. 16.

kind shows at a glance the force exerted on the piston and the opposing force acting against it, at what point they equalize each other, and the exact relation that one bears to the other. In fig. 14 the curved line *A B* represents the influence of the reciprocating parts and angularity of main rod for the forward stroke, and *C D* correspondingly for the back stroke.

Commencing with the forward stroke indicator card, the distance which the curved line *A B* is above or below the horizontal line *E F* (representing the initial pressure) must be taken from or added to the indicator diagram measured on the vertical lines. The irregular curved line *h j k* is thus produced, representing the actual force exerted on the crank-pin. The opposing force or back pressure on the other side of the piston is represented by the curved line *l m n o*. The effec-

tive pressure, then, for any position of stroke would be the distance measured on any vertical line bounded by these curved lines, and shown in diagram by cross-hatching.

It will be observed that the small triangular space $l\ m\ k$ represents back pressure or minus quantities.

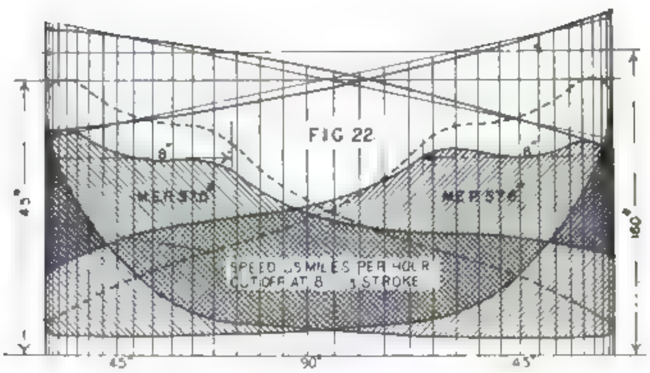
The card for back stroke is corrected in a similar manner, commencing at D, the steam pressure being represented by the line $D\ p\ r$. The triangular space $D\ G\ l$ being deduced from the steam card, and $E\ G\ O$ being the space above the horizontal line, added to the card. The back pressure on the back stroke is shown by the irregular curved line $E\ s\ t\ u\ v$. The small triangle $E\ s\ r$ represents the back pressure or minus quantity. The most noticeable feature about this diagram, fig. 14, is that the correction for the acceleration or retardation of the reciprocating parts exactly reverses the conditions shown by the primary indicator card. The pressure on crank-pin is much less at the commencement of the stroke than at the completion, showing clearly that the weights of piston, etc., viewed entirely from a stationary engine standpoint, and without reference to any injurious effect on the track, are too heavy for the speed, steam pressure, etc.; also that the smooth running of the engine at this velocity would be improved by their reduction in weight. Fig. 16 represents the effect of the reciprocating parts weighing 420 lbs., constructed as previously shown in figs. 4, 5, 6 and 7, all other conditions being similar to fig. 14. This shows almost the same pressure on the crank-pin at the commencement and completion of the stroke, and represents very nearly the most suitable weight at this speed for correcting the irregular steam pressure, and modifying it so that an almost uniform pressure on the crank-pin is produced.

Turning again to the curves of tractive force plotted out at the bottom of fig. 8, the effect of the light and heavy reciprocating parts, and the relation existing between the vertical

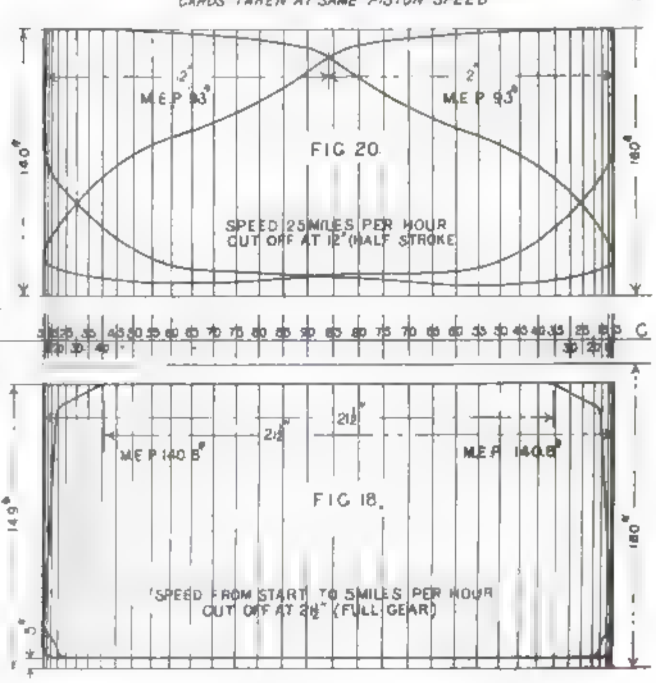
if the point is stopped successively at the intersection of the radial and circumferential lines, the exact position of the piston for each 5° of crank movement will be accurately located on the horizontal line $B\ C$. The varying turning moments, due to the angularity of the rod, and the different positions of the crank, are obtained by calculating the ratio existing between the radius of the crank and the vertical height of the lines representing the center of the main rod for the forward stroke, where they intersect the vertical line $D\ E$. For the back stroke, the lines representing the center of the main rod must be prolonged until they intersect the vertical line $D\ E$.

If the length of the crank is divided into a thousand parts, the vertical height, measured from the horizontal line $B\ C$ by the scale, will equal the coefficient marked on the radial lines outside the periphery of the circle.

The tractive force, then, for one side at each 5° can be obtained as follows:



INDICATOR DIAGRAMS BASED ON ACTUAL CARDS TAKEN AT SAME PISTON SPEED



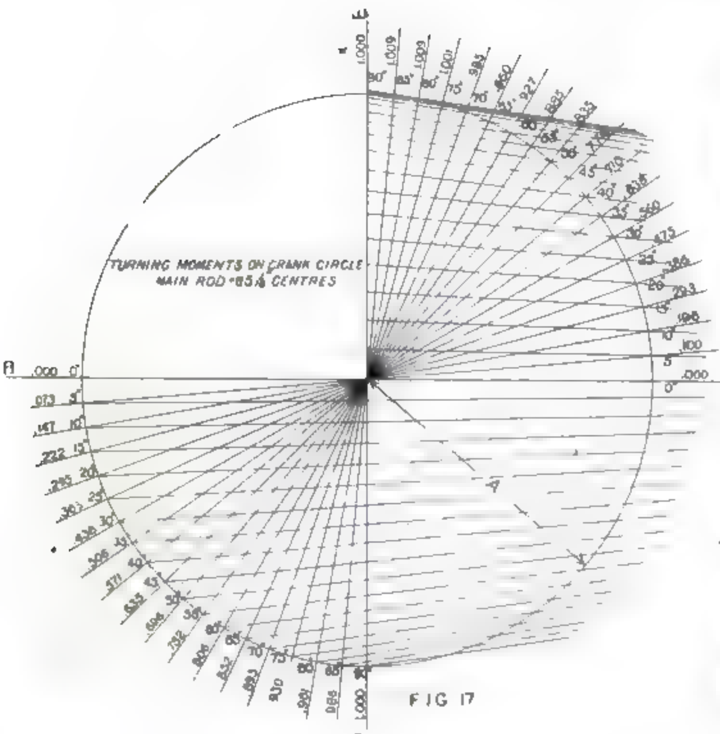


FIG 17

effect on track of same, is clearly shown. The effect of the heavy parts (589 lbs.) is shown in full lines, the right and left sides separately in lighter, and the combined effect of both sides in heavier lines, while the curves of the light parts (420 lbs.) are shown in the dotted lines. The manner of plotting these curves is as follows: The turning moments on crank circle for each 5° of crank angle are obtained by constructing a diagram, fig. 17, and calculating therefrom the coefficient for each angle.

Take any convenient scale and make A equal to the length of crank, $B\ C$ the horizontal center line prolonged sufficiently to the right to take in the length of the main rod, and $D\ E$ the vertical center line; divide the two diagonal quarters by radial lines 5° apart. Then, with an opening of dividers equaling the length of the main rod from center to center ($85\frac{1}{16}$ in.),

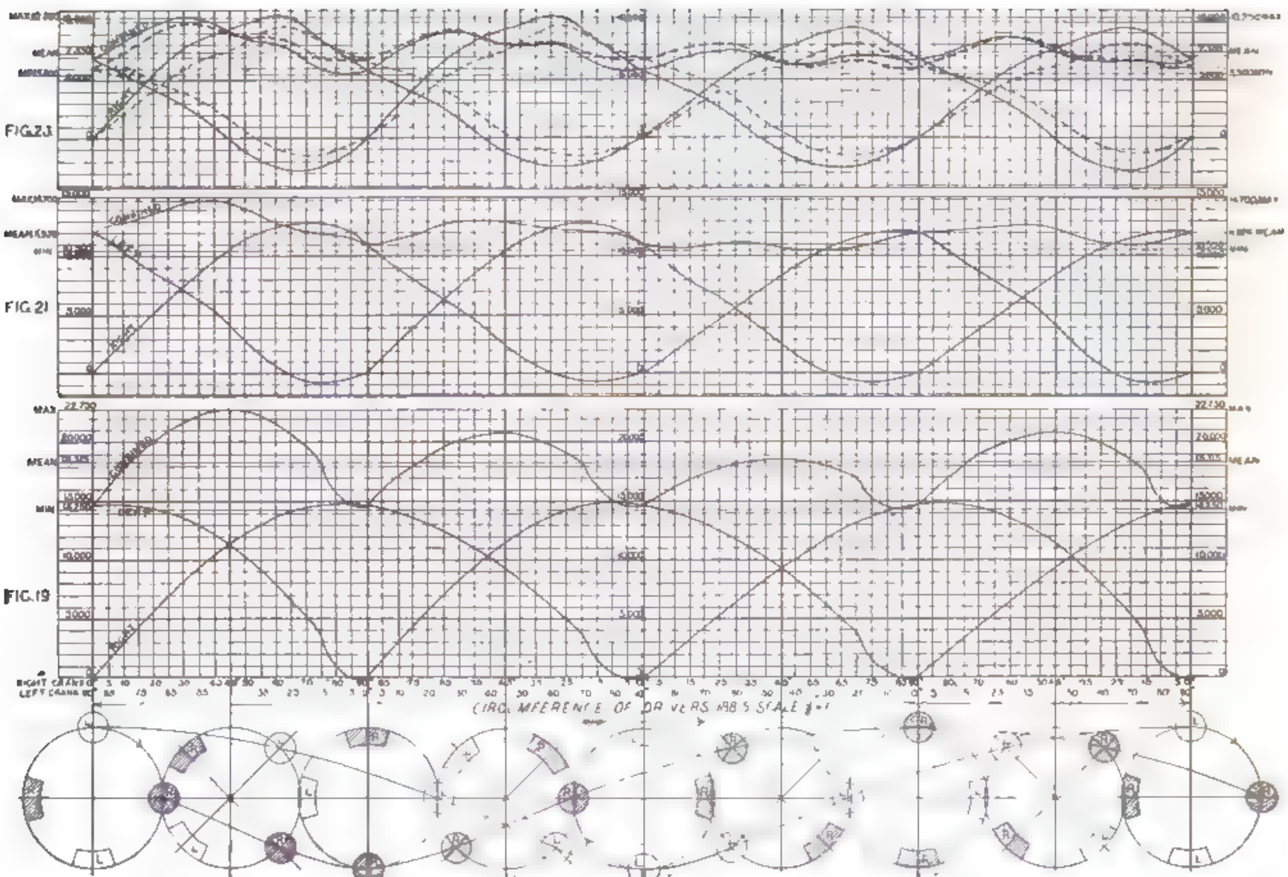
R = radius of wheel;
L = " " crank;
C = coefficient for each 5° of crank angle;
E = effective pressure from diagram at each 5°;
T = tractive force for one side at each 5°;

$$T = \frac{C \times L \times E}{R} = \frac{C \times 12 \times E}{30} = \frac{C \times E}{2.5}.$$

These curves are located for each side and combined in a similar manner to the curves for vertical effect.

The fluctuations in the tractive force can be best shown by digressing for a few moments, and considering only the tractive force at starting and at slow speeds without reference to the reciprocating parts.

An indicator card for the same class of engine speed, start to 5 miles per hour with a cut-off of 21½ in. (full gear), is shown in fig. 18, with corresponding curves shown in fig. 19. This gives a mean tractive force of 18.315 lbs.—minimum, 14,250 lbs., and maximum, 22,750 lbs.; the latter equaling 31 per cent. of the total weight on the drivers, and the mean obtainable from an engine of the same dimensions in ordinary mixed service—speed, 30 miles per hour; cut-off, 8 in. (one-third stroke). Fig. 25 gives the curves for tractive force—maximum, 11,700 lbs.; minimum, 7,400 lbs.; mean, 9,580 lbs.—showing an increase on the mean effect of 1,730 lbs., or 23.8 per cent.



equaling 25.8 per cent. of the same. Taking the mean effective pressure at 140.8 lbs., as shown on the diagram, and calculating the tractive force by the usual formula,

$$\frac{D^2 \times L \times 140.8}{W} = 18,247 \text{ lbs.}$$

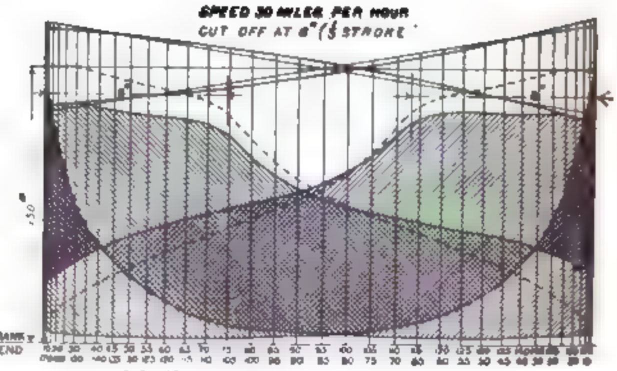
Or, taking 85 per cent. of the boiler pressure,

$$\frac{D^2 \times L \times .85\,(160)}{W} = 17,625 \text{ lbs.}$$

Fig. 19 shows graphically the reason it is not desirable to increase the mean tractive force above about 25 per cent. of the total weight, except, perhaps, in some exceptional cases, such as engines working exclusively on steep grades, where it is often necessary to start a heavy train with the cranks in any position, the most difficult being when one is on the dead center.

Fig. 20 is a card at 25 miles an hour, cut-off at one-half stroke, mean effective pressure 93 lbs. The tractive force of this card is plotted in fig. 21—maximum, 14,700; minimum, 10,500; mean, 11,926. Except in the position from 35° to 40° on the forward stroke, the tractive force is remarkably uniform, the fluctuations not exceeding 2,000 lbs. The speed at 35 miles per hour, given in fig. 22—cut-off, 8 in. (one-third stroke); mean effective pressure, 57.6 lbs. This diagram is corrected for the influence of reciprocating parts. The corresponding tractive force is given in fig. 23—maximum, 10,250 lbs.; minimum, 5,500 lbs.; mean, 7,350 lbs. The tractive force, based on the primary card, is shown on dotted lines, and the corrected card in full lines. These three cards, figs. 18, 20, 22, are based on actual indicator diagrams taken at the same speed. It will be interesting at this point to compare the last one with a corrected, made-up diagram, fig. 24, representing the maximum, mean, effective pressure considered

The great gain in this is at once apparent, although the limiting efficiency of a freight engine is usually by its failure to surmount some difficult place on the road, where the grade is a little steeper, longer, or the curves sharper than the normal conditions.



CORRECTED DIAGRAM REPRESENTING THE MAXIMUM MEAN EFFECTIVE PRESSURE OBTAINABLE FROM ENGINE OF THESE DIMENSIONS IN ORDINARY MIXED SERVICE

Fig. 24.

The speed would be much slower, no doubt, on these conditions. This, however, serves as an illustration of the improvement which can often be effected by the reduction of back pressure, higher initial pressure, etc.

Among the superior attributes of the future motive power—the electric locomotive—will, no doubt, be its uniform turning moment. The tractive force drawn in the same manner would be a straight horizontal line, which could be raised at

pleasure in parallel lines from zero to the maximum, allowing the total adhesion to be utilized.

Some interesting but impossible indicator diagrams can be made by reversing the process and drawing the line of tractive force straighter than it actually appears, filling in the low places and cutting down the high points in the attempt to make it more uniform. Such efforts, while they are instructive and useful at some speeds, must necessarily be extremely limited where most needed—that is, for cards taken at the start to 3 or 4 miles per hour.

The conclusions reached by the writer are: First, that the most profitable course to pursue to reduce the vertical effect of counterbalance is to lighten the reciprocating parts, considering carefully the strains to which they are subjected, and paring down the unnecessary weights to a minimum wherever possible; 25 per cent. can be removed without unduly weakening the parts, and in many cases a much greater improvement can be effected.

Second, for high-speed engines decrease the piston speed, and consequently the revolutions per minute, by increasing the diameter of the drivers; as the centrifugal force increases directly as the square of the number of revolutions per minute, the effect is very marked.

At 70 miles per hour the number of revolutions per minute, with 68 in. drivers, is 346, 346^2 = 119,716
" 78 " " " 301, 301^2 = 90,601

29,115,

the reduction in centrifugal force being 24.3 per cent., effecting at the same time a much better distribution of steam and greatly reducing the wear and tear of machinery.

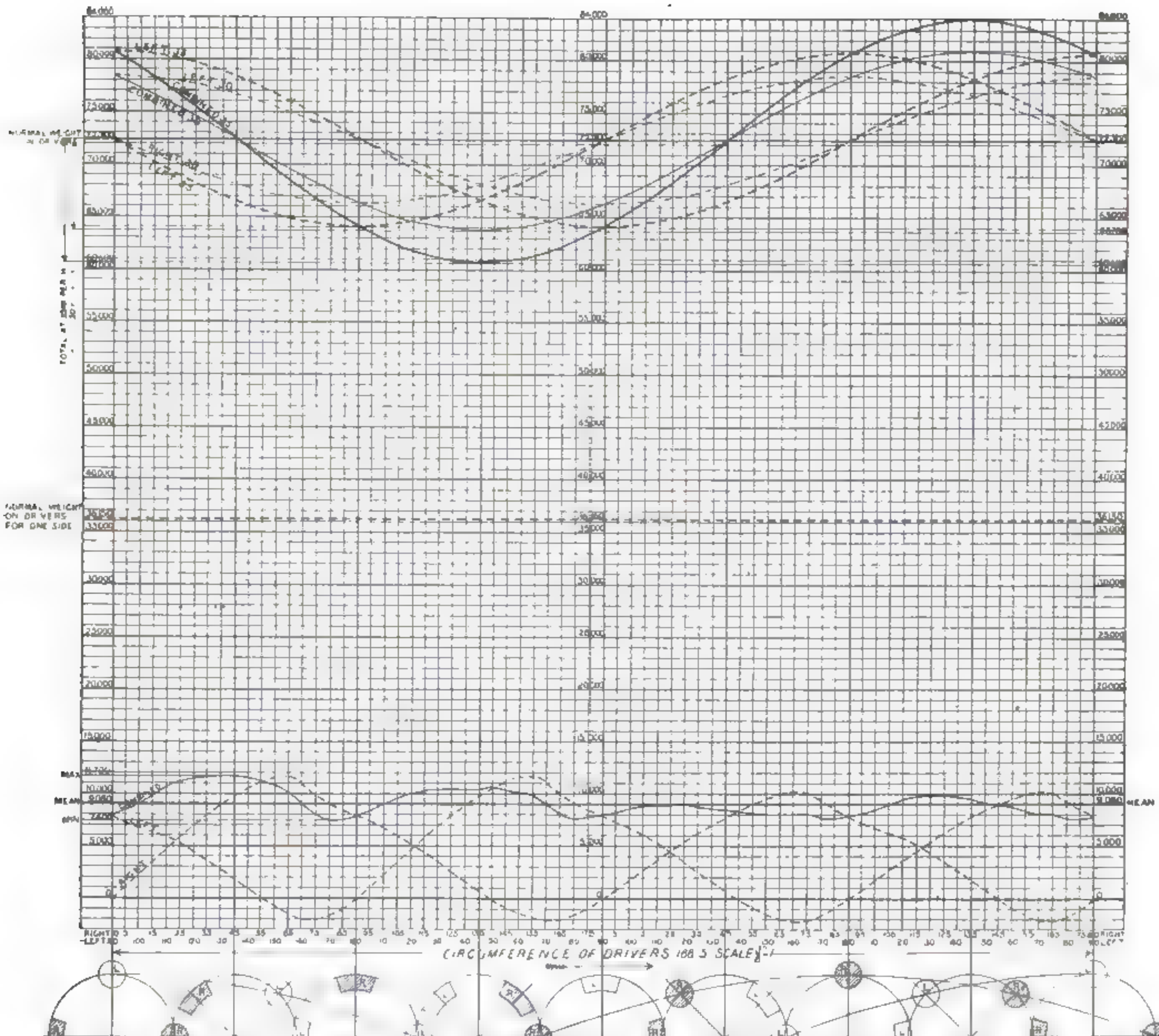


Fig. 25.

A NEW FOG-SIGNALING APPARATUS.

Though the public, in the extraordinary change of climate which has come over England in the last 12 months, may have almost forgotten the meaning of the words "London fog," the matter is not likely to pass from the mind of the railway manager. Year by year as railway traffic gets denser and railway lines are more crowded, the delays and expense caused by a serious fog become more intolerable. Nor is this the only reason why the old-fashioned detonator fastened to the rail

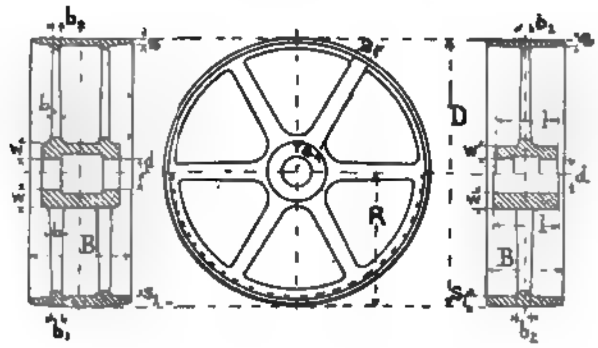
with a wire clip by human agency is constantly felt to be more inadequate for its purpose. A fog-man must not only be a trained railway man, but also must be familiar with the exact spot at which he is called to work. With the new ideas that have grown up on the subject of permissible length of hours of labor, the supply of such men is likely to fall short. The risk, moreover, of the occupation is inevitably great, and risks of this kind are less submissively borne than was the case a few years back. For all these reasons, a satisfactory mechanical system to replace manual labor entirely is likely to meet with a cordial welcome. Before, however, any system can be accepted as satisfactory, it will, undoubtedly, have to run the gauntlet of a great deal of keen professional criticism, and to survive the ordeal of long and severe tests in every-day use. Meanwhile, a very interesting and in several respects novel mechanism has been experimentally fitted up a few miles out of London on the new Tottenham & Forest-gate Line, where it has been examined with interest by a number of practical railway men. Seeing that patents for fog-signaling apparatus have fallen for years past almost as thick as the leaves in Vallombrosa, and that the bulk of them have been wholly unworkable in practice, whatever might be their theoretic advantages, it is well for the new apparatus that its patentees are not amateurs, but engineers by profession. They are Mr. George Abernethy, the son of the famous engineer, and Mr. Timmis, the maker of the first automatic signals ever introduced in England, which have now been working with entire success for months past on the Liverpool Overhead Railway.

In brief outline the system consists of a wire circuit passing down the signal-post and along the line to the signal-cabin, then back to a point opposite the signal, where it is attached to a contact-bar laid on the ground between the rails. With this bar connection is made as each train passes by a wire brush fixed on the front of the locomotive, and the circuit is completed by the current passing out through the wheels of the locomotive and so along the rails to the point of origin. Both on the engine and in the signal-cabin the current is led through an instrument, looking much like an ordinary block-signal instrument, with a polarized needle, so that as long as the circuit is open the needle hangs straight up and down; but when the circuit is closed by the brush on the locomotive coming in contact with the bar fixed between the rails, the needle is deflected to the one side, giving "line clear," if the position of the signal causes the current to flow in the positive direction, to the other side, showing "danger," if the signal arm is up and the current is accordingly a negative one. Further, the indicator on the engine is supplemented by an audible signal, and according as the current comes from a signal that is "off" or "on," it either rings a shrill chattering bell or strikes a deep-sounding gong. The engine-driver, therefore, has no need to watch his indicator, and might know whether the line was clear even though he were out on the running board with his head under the boiler while he was oiling the motion. If it is thought necessary, it would be easy to fit up similar audible signals in the signalman's cabin also. A further requirement is met by this new patent. Conflicts frequently arise on the occasion of an accident between drivers and signalmen as to who was responsible—whether it was the driver who passed a signal of danger, or the signalman who left it "off" when it ought to have been "on." Messrs. Abernethy and Timmis are prepared to attach to the signals an automatic recorder which, working with a train of wheels something after the fashion of an ordinary gas meter, shall keep count both for driver and for signalman, in the one case of every signal the engine has passed, in the other case of every train which has passed the signal.

Such is, very briefly, the new apparatus. Whether it will come into practical use it is, of course, impossible for any one to say, for though the apparatus is far from costly, requiring only, it is said, an expenditure of something like 50s. per engine, it is a serious matter to undertake a wholly new departure where the safety of the traveling public is involved. But it is possible at the outset to find more than one point which should be strongly in its favor. In the first place, it gives not merely a negative but a positive signal. The existing fog signals only tell a man now and then that he must stop instantaneously. The new system would tell him each time he passed a signal showing "line clear" that he might proceed with safety. And the difference may, at times, be of vital importance, for accidents have happened before now through drivers losing their bearings entirely, and suddenly finding themselves some miles further along the line than they had supposed. Then, again, the indicators, both in the signal cabin and on the engine, being on the same circuit, it is impossible for them to tell two contradictory tales at the same moment. Not only does the driver know where the signal is, but the signalman knows it too, and the driver knows that the signalman knows it. With these great advantages in its favor at the outset, we shall probably hear more before long of Messrs. Abernethy and Timmis's fog-signaling patent.—*London Times.*

DIMENSIONS OF CAST-IRON PULLEYS (DOUBLE ARMS)

BREADTH FROM 11 IN. TO 14 IN.



[illegible]	No. of Arms.	a	a_1	b	b_1	s	s_1
6 to 12	2×4	1[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]
12[illegible] " 16[illegible]	2×4	1[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]
16[illegible] " 19[illegible]	2×4	1[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]
20 " 23[illegible]	2×6	1[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]
24 " 27[illegible]	2×6	1[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]
28 " 31[illegible]	2×6	1[illegible]	1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
32 " 35[illegible]	2×6	1[illegible]	1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
36 " 39[illegible]	2×6	1[illegible]	1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
40 " 43[illegible]	2×6	1[illegible]	1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
43[illegible] " 47[illegible]	2×6	1[illegible]	1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
47[illegible] " 51	2×6	1[illegible]	1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
51[illegible] " 55	2×6	1[illegible]	1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
55[illegible] " 61	2×6	2	1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
61[illegible] " 67	2×6	2[illegible]	1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
67[illegible] " 72[illegible]	2×6	2[illegible]	1[illegible]	1	[illegible]	[illegible]	[illegible]
67[illegible] " 72[illegible]	2×8	1[illegible]	1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
72[illegible] " 78[illegible]	2×6	2[illegible]	1[illegible]	1	[illegible]	[illegible]	[illegible]
72[illegible] " 78[illegible]	2×8	2[illegible]	1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

$$W = \frac{d}{6} + \frac{D}{100} + \frac{3}{8} \text{ to } \frac{d}{6} + \frac{D}{100} + 1\frac{1}{8}$$

$r = 0.80\ a$ = radius of elliptical arm.

BREADTH FROM 14½ IN. TO 20 IN.

D.	No. of Arms.	a	[illegible]	b	b_1	s	s
6 to 12	2×4	1[illegible]	1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12[illegible] " 16[illegible]	2×4	1[illegible]	1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16[illegible] " 19[illegible]	2×4	1[illegible]	1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20 " 23[illegible]	2×6	1[illegible]	1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
24 " 27[illegible]	2×6	1[illegible]	1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
28 " 31[illegible]	2×6	1[illegible]	1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
32 " 35[illegible]	2×6	2[illegible]	1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
36 " 39[illegible]	2×6	2[illegible]	1[illegible]	1	[illegible]	[illegible]	[illegible]
40 " 43[illegible]	2×6	2[illegible]	1[illegible]	1	[illegible]	[illegible]	[illegible]
43[illegible] " 47[illegible]	2×6	2[illegible]	1[illegible]	1[illegible]	[illegible]	[illegible]	[illegible]
47[illegible] " 51	2×6	2[illegible]	1[illegible]	1[illegible]	[illegible]	[illegible]	[illegible]
51[illegible] " 55	2×6	[illegible]	1[illegible]	1[illegible]	[illegible]	[illegible]	1
55[illegible] " 61	2×6	[illegible]	1[illegible]	1[illegible]	[illegible]	[illegible]	1
61[illegible] " 67	2×6	[illegible]	1[illegible]	1[illegible]	[illegible]	[illegible]	1
67[illegible] " 72[illegible]	2×6	2[illegible]	2[illegible]	1[illegible]	[illegible]	[illegible]	1[illegible]
67[illegible] " 72[illegible]	2×8	2[illegible]	1[illegible]	1[illegible]	[illegible]	[illegible]	1[illegible]
72[illegible] " 78[illegible]	2×6	2[illegible]	2[illegible]	1[illegible]	[illegible]	[illegible]	1[illegible]
72[illegible] " 78[illegible]	2×8	2[illegible]	1[illegible]	1[illegible]	[illegible]	[illegible]	1[illegible]

$$W = \frac{d}{6} + \frac{D}{100} + \frac{3}{8} \text{ to } \frac{d}{6} + \frac{D}{100} + 1\frac{1}{8}$$

$r = 0.80\ a$ = radius of elliptical arm.

—*Mechanical World.*

THE VIBRATIONS OF STEAMERS.

Further Investigations of the Vibrations of Steamers.*

By Herr Otto Schlick.

The paper which I had the honor to lay before you at the last year's meeting of the Institution of Naval Architects appears to have been sufficiently interesting to the members to encourage me to communicate to you now the results of my further investigations on the same subject.

It is no doubt very desirable to have a reliable formula for determining with some degree of accuracy the number of revolutions which the engines of a steamer should make in order to avoid altogether, or at least reduce to a minimum, the violence of the vibration inherent in ships themselves, and in the distribution of the weights in them. Such a formula I had already worked out some time ago, but before publishing it I took care to test and correct the coefficients occurring in the formula, by applying it to a number of steamers already doing service.

This was not an easy task for me, as I had not the opportunity of ascertaining, with accuracy, the critical number of revolutions of the engines above referred to, excepting in the case of a very limited number of steamers in the merchant service. Many vessels vibrate violently when running under steam, but in most cases the revolutions of the engines cannot be increased to the number necessary to bring about a decrease of the vibrations; so that this critical number of revolutions can ordinarily not be ascertained.

The mathematical formula for the period of vibration of an elastic rod or girder is very complicated, but in the case of a ship's hull its compilation is comparatively simple. Let an imaginary weightless elastic rod be firmly secured at one end, while at the other end let the mass M be attached and the force Q applied. The latter will bend the rod and move the mass M through a distance λ from its original position, to which M will return with a certain acceleration, when the force Q is withdrawn.

If the acceleration at the distance 1 from the horizontal position of the rod is called q, then the time of oscillation of the rod will be found by the well-known formula

$$t = \frac{W}{\sqrt{q}}.$$

If, now, the force K is applied to the free end of the rod, and the distance through which M is moved downward by this force is equal to χ, then

$$\frac{K}{Q} = \frac{\chi}{\lambda},$$

that is, the distance through which the free end of the rod is moved by the bending forces are proportional to these forces.

If the acceleration given to M by the bending force K at a distance χ is called p, then

$$p = \frac{K}{M} = \frac{Q}{M\lambda}\cdot\chi.$$

If χ is put equal to 1, then will be,

$$q = \frac{Q}{M\lambda},$$

λ signifying the distance through which the rod is bent by the force Q, and $\frac{\lambda}{Q}$ being a constant quantity, λ_1 may be put for λ in the case of the bending of the rod having been caused by the weight of the mass M alone. We can, therefore, put

$$Q = Mg,$$

g signifying the acceleration of gravity. Therefore the time of oscillation is

$$t = W\sqrt{\frac{\lambda}{g}}. \qquad (1)$$

The distance χ through which an elastic prismatic rod is bent by the force K, the weight of the rod being neglected, may be found by means of the formula,

$$\chi = \frac{K \cdot l^3}{3 \cdot E \cdot T}, \qquad (2)$$

l signifying the length of the rod, E the modulus of elasticity of the material, T the moment of inertia of the section of the rod.

If, now, in the formula (1), instead of λ_1, the value of χ from the formula (2) is put, we have

$$t = W\sqrt{\frac{K l^3}{3 \cdot E \cdot T \cdot g}}. \qquad (3)$$

The direct application of this formula for calculating the time of oscillation in the case of a ship's hull is, however, only admissible on the supposition that the weight of the ship is concentrated in one point. Therefore $\frac{L}{2}$, half the length of the ship, must not be put at once instead of l in formula (3). It is, however, admissible to suppose that the weight of half the ship, the same being divided by the midship section into two equal parts lengthways, is concentrated in one point at a certain distance from the midship section, and that the time of oscillation in this imaginary case be the same as in that of a real ship, in which the weights are distributed in the usual way along the whole length.

This imaginary distance may be expressed by $a \times \frac{L}{2}$ (a being smaller than 1), but need not be taken into consideration at present.

Upon this supposition the formula (3) may be used at once to determine the time of oscillation for a ship.

If D signifies the displacement (weight) of a ship, then is the time of oscillation expressed by the formula

$$t = W\sqrt{\frac{\frac{D}{2}\cdot\left(a\frac{L}{2}\right)^3}{3 \cdot E \cdot T \cdot g}}.$$

The joint value of all the factors in this formula being put equal to ξ, we have

$$t = \xi\sqrt{\frac{D \cdot L^3}{T}}.$$

From which follows, if the number of vibrations of a certain type of ship per minute be

$$N = \frac{60}{t},$$

$$N = \phi\sqrt{\frac{T}{D \cdot L^3}}.$$

If in this formula D is expressed in English tons, L in English feet, and, for the calculation of the moment of inertia, the sectional areas in English square inches, and the distances of the centers of gravity from the neutral axis in English feet, then the coefficient will be, for

Vessels with very fine lines, such as torpedo-boat destroyers.................................. $\phi = 156850$
Large transatlantic passenger steamers with fine lines.. $\phi = 143500$
Cargo boats, with full lines..................................... $\phi = 127900$

This formula gives generally reliable values, and even alterations in the distribution of weights do not materially influence the result.

In order to adjust the coefficients to exceptional cases, it is only necessary to bear in mind that a removal of the weights from the ends and the middle of a ship—viz., an accumulation of the weights near the nodular points of vibration, will increase the number of vibrations, and, *vice versa*, that this number will decrease when the weights are accumulated near the ends and the middle of a ship.

It would, of course, be more correct to consider in the formula the distribution of the weights in the longitudinal axis of the hull; but as this would require a very tedious calculation, which would, moreover, not always be reliable, and as I consider it particularly important to construct a formula which easily adapts itself to practical use, I have thought it better to employ only the coefficient ϕ, which I ascertained

* Paper read before the Institution of Naval Architects.

from results obtained with reference to existing ships. After more experience has been gained, it will be possible to find perhaps more correct coefficients for the ordinary types of steamers in which the distribution of the weight is analogous.

In order to avoid vibration with perfect certainty, the normal number of revolutions must, as is known from experience, be at least from 10 to 12 per cent. less, or else considerably greater than the number of vibrations. In case the number of revolutions should be only inconsiderably greater, there could arise the possibility that even a small diminution of the steam pressure, hardly always to be avoided in practice, would immediately cause vibrations of great violence.

A ship's vibrations have until now never been closely examined with regard to the influence exercised by the position of the engines in the ship, and I myself touched this subject only

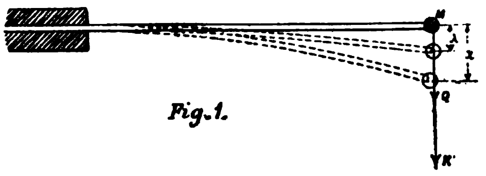


Fig. 1.

superficially in my previous publications. Although it is comparatively easy to find out the consequences of shifting the engines in a ship by argument, yet the attempt to prove the conclusions arrived at by practical tests on a steamer will remain very costly and difficult. I therefore had recourse to a model to show the results caused by shifting the engines of a ship in a fore-and-aft direction.

This model, represented by figs. 2 and 3, consists principally of a plank, *P P*, about 8 ft. long and 11 in. broad, suspended horizontally by 10 helical springs, *S S*, arranged in two rows lengthways near the edges of the plank. These helical springs are attached to a frame, *F F*, the construction of which is immaterial.

Along each edge of the plank *P P* are also arranged in two rows a number of weights, *W W*, which can be easily shifted.

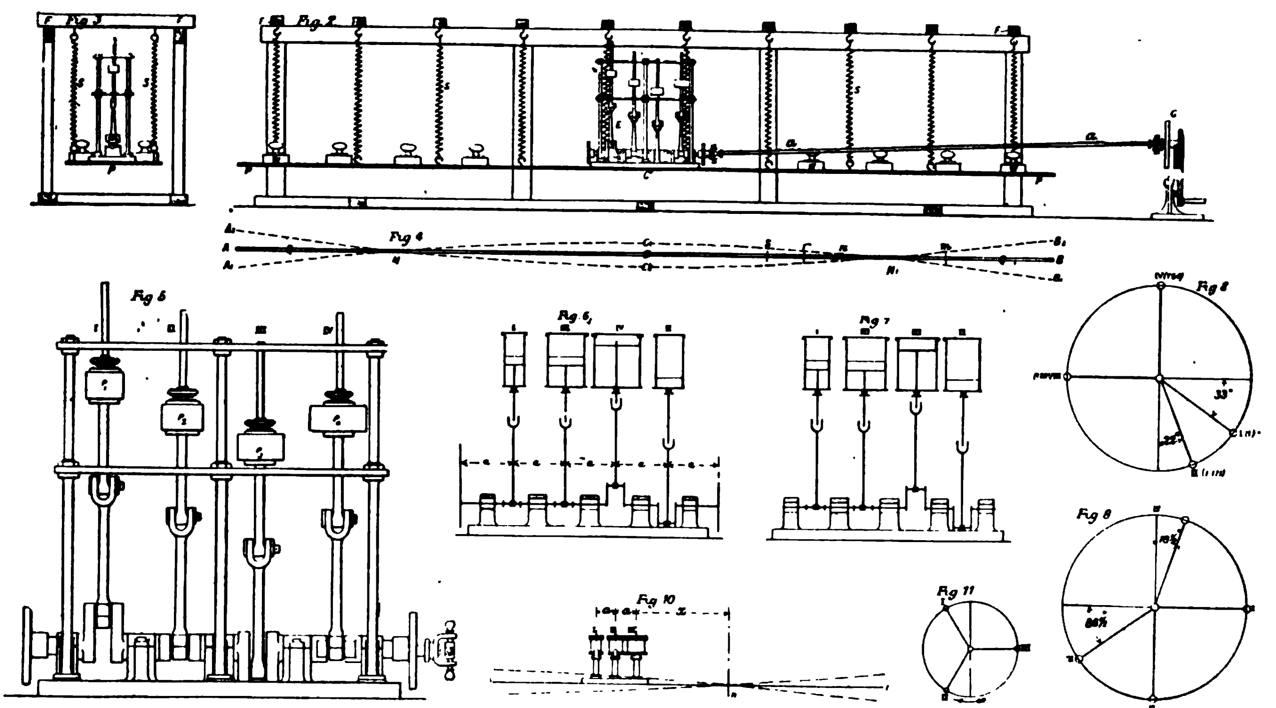
The plank suspended, as above described, can thus easily be made to vibrate in the manner shown at fig. 4, by a regularly repeated impulse of the hand, either at the middle or at the ends. These vibrations will be called in future vibrations of the I. order, in distinction from vibrations of another kind. Every one who has been on board a violently vibrating steamer will acknowledge at once the perfect analogy of the vibrations of the plank with those of a steamer.

A model engine, as shown at fig. 5, serves for further investigations. The shaft has four cranks, which can be easily adjusted at any angle with each other by a screw arrangement. The pistons are represented by four different weights p_1, p_2, p_3, p_4, which can be easily removed and exchanged for others, to show the effect produced by the use of pistons of different weights. This model engine is placed, as shown at fig. 2, on the plank *P P*, and made to revolve by the turning gear *G* in connection with the spindle *a a*, which is furnished at each end with a universal joint and also with a telescopic sliding arrangement, so that the engine *E* can work perfectly freely.

Another model engine of similar construction, but with three cranks, is used to explain the influence of ordinary triple-expansion engines on the vibration of steamers.

In the first place, let the pistons, piston-rods, and connecting-rods of two cranks of the three-crank engine be removed, so that the model may represent a tandem engine—viz., an engine with only one crank. When the apparatus in this state is set in motion, only forces acting alternately up and downward in a vertical direction will come into action, without any rocking couples being formed in the vertical plane through the longitudinal axis of the ship.

If the model engine be placed at *C*, the middle of the plank representing the ship (see fig. 4), and made to work first slowly and then gradually faster, it will be observed that the plank will remain at rest until the revolutions have reached a certain number, when violent vibrations of the form A_1 C_1 B_1 and A_2 C_2 B_2 (see fig. 4) will make themselves manifest. The violence of these vibrations will, however, decrease again to perfect rest when the number of revolutions of the engine is gradually increased. Exactly the same will be observed when the model engine is shifted to *O* or *Q* near the end of the plank.



APPARATUS FOR EXPERIMENTING ON THE VIBRATIONS OF STEAMERS.

This plank represents a ship's hull, and by means of it the origin of vibrations in a ship may be demonstrated, by applying to it forces, in a similar way as they would occur in reality in a ship. If, for instance, at one part of the plank a pressure is exercised, the plank will give way in the direction of that pressure either up or downward, until through the increased tension of the respective springs equilibrium is re-established, similar to the action of increased buoyancy in the case of a ship.

When, however, the engine is placed exactly over one of the nodular points *N* or N_1, then the plank will remain at rest, or nearly so, at any number of revolutions that the engine may be worked at. The vibrations, as shown at fig 4, will be replaced by others of a higher order, having more than two nodular points, depending on the number of revolutions the engine is worked at.

These facts are, however, of little use in practice, as it is impossible to determine with accuracy the position of the

nodular points for a ship in course of construction; moreover, that position is not constant, but varies with the distribution of the weights in the ship.

For further investigations, the cranks belonging to the cylinders I. and IV. of the model engine, shown at fig. 5, are placed exactly opposite to each other—viz., at an angle of 180°. The weights of the two respective pistons p_1 and p_4 are made exactly equal, and the two connecting-rods and piston-rods of the cylinders II. and III. are removed altogether. With such an engine with two cylinders the algebraical sum of the forces will always be zero—viz., they will be perfectly balanced in a vertical direction at any position. During the first half of a revolution a couple will be created, having the tendency to lift the engine-bed abaft, and during the second half a couple with the exactly opposite tendency.

When such an engine is placed exactly in the middle of the ship, vibrations of the I. order, as shown at fig. 4, cannot be produced, but the ship will remain at rest. Only small vibrations will occur when the engine is placed near the end of the plank, considerably abaft the nodular point. Both assertions can be proved by experiments with the model.

When, however, this engine is placed with its two cylinders equidistant from the nodular point (that means when one cylinder is placed at the same distance after the nodular point as the other one is placed before it), very violent vibrations of the I. order will be produced as soon as the revolutions of the engine have reached the critical number. This can easily be gathered from fig. 4, considering that during the first half of a revolution a downward force at n, and an upward pressure at m, will take place simultaneously, and that these pressures will be reversed during the second half of the revolution. Vibrations will also be produced when the engine is placed with its cylinders not equidistant from the nodular point.

If, for an instance, one of the cylinders is placed exactly over the nodular point N_1, fig. 4, and the other toward the middle of the ship over r, the thrusts of the piston acting exactly over the nodular point will have no effect in producing vibrations, while the thrusts of the other piston acting at a distance from the nodular point will cause violent vibrations.

In shifting the engine gradually toward the middle of the ship, the vibrations will decrease in the same measure until they entirely disappear as soon as the engine has reached the middle position.

The following rules, based on the above-described experiments and observations, may be laid down for the construction of a ship's engines, so as to avoid vibrations:

1. In the case of engines that are placed exactly at the middle of the ship or near its ends, the algebraical sum of the vertical forces generated by the reciprocating masses must be made equal to zero. Rocking couples, which may possibly arise, need not be taken into consideration, as their influence in producing vibrations is but small.

2. In the case of engines that are placed over or near one of the nodular points, rocking couples acting in the vertical plane through the longitudinal axis of the ship must be avoided, in order to do away with vibrations. It is, however, less important that the algebraical sum of the vertical forces be equal to zero.

The second case only will come into consideration in practice, as it is impossible, under ordinary circumstances, to place the engine in the middle of the ship. On the contrary, it will be requisite for the proper arrangement of the boilers to place the engine considerably abaft, near to the nodular point

In designing the engine special care must, therefore, be taken to avoid rocking couples.

The usual arrangement of a three-cylinder engine is that the high-pressure cylinder is placed foremost, the middle-pressure cylinder in the middle, and the low-pressure cylinder at the after end.

Considerable rocking couples will always be produced with such an arrangement, and, moreover, the alternately upward and downward forces at the after end of the engine-bed will be greatly in excess of similar forces at the fore end, because the weight of the low-pressure piston is naturally greater than that of the high-pressure piston. An ordinary triple-expansion engine may, therefore, be used when it is placed before the nodular point in question, because then the greater pressures are applied nearer to that point than the smaller, and the engine will therefore work better.

But when the engine is placed abaft the nodular point, as is generally the case with tank steamers, then the greater force will act also at a greater distance from the nodular point, and cause, therefore, more violent vibrations. The usual position now given to triple-expansion engines in tank steamers is, therefore, as regards producing vibrations, the most unfavorable. The low-pressure cylinder of the engine should be placed foremost, and the high-pressure cylinder abaft.

Moreover, the rocking couples, inherent in a triple-expansion engine, would be considerably reduced if the low-pressure cylinder were arranged between the high and middle-pressure cylinders, because then the greatest pressures produced by the reciprocating masses would act nearly in the center of gravity of the engine. With such an arrangement not only the violence of the vibrations would be reduced, but also the strain on the engine-bed, which often causes loosening of the fastenings.

It is, therefore, to be recommended for any engine of the three-cylinder type, the low-pressure cylinder should be placed in the middle between the two other cylinders. In the case of an engine with five cylinders and three cranks—viz., one cylinder for the middle crank, and a pair of cylinders for each of the outer cranks, very great rocking couples are produced, as the piston weights for each pair of the outer cylinders are considerably greater than that of the middle cylinder. These engines will, therefore, cause especially violent vibrations.

An ordinary triple-expansion engine with three cranks, if erected in a particular manner, would also not be able to put the body of the ship into a state of violent vibration. To make this clear, refer to figs. 10 and 11. Let the line A B represent the axis of the ship; let N be the aftermost nodular point, let B be the stern, and A about the middle of the ship. Let it be also assumed that the engine, as is usually the case, is placed somewhat in advance of the nodular point. When the revolution of the engine takes place in the direction indicated by the arrow in fig. 11, and the cranks occupy, for example, the position shown, the weight of the piston of cylinder No. III. will generate a considerable upward force, while the pistons of cylinders Nos. I. and II. generate forces in the opposite direction. If, now, the distance x of the engine from the nodular point N be such that the moments of these forces about the nodular point N be equal to zero, no vibrations of the first order can take place.

As, however, the weights of the moving parts of the separate cylinders of an ordinary triple-expansion engine generally stand to each other in the ratios of 1 : 0.82 : 0.78, we have, in order that no vibrations may take place, the simple calculation that the distance x of the low-pressure cylinder must be about five times a, the distance apart of the cylinders from center to center. It results, also, that for every type of engine there is a position in the ship where the engine may be erected which renders it possible to avoid vibrations.

By proper balancing rocking couples, as well as vertical forces, vibrations may be avoided altogether. The use of counterweights is, however, not expedient, when the same have to be too heavy, and is almost inadmissible for very large engines. For instance, for a triple-expansion engine of 7,000 indicated H.P., the counterweights required would amount to 44 tons, if the stroke of the eccentrics for moving these weights be 20 in. at one end and 12 in. at the other end of the engine. It is, therefore, by all means necessary to reduce the counterweights to a minimum, or, better still, to do away with them altogether. This may be carried out partially by giving the engine a proper construction or position in the ship.

With this object in view, the weights of the three pistons for a three-cylinder engine have been made exactly equal. With such a construction the algebraical sum of the vertical forces is equal to zero for any position of the cranks; and if such an engine be placed exactly in the middle of the ship, no vibrations could be produced, as has been demonstrated before. But as soon as such an engine is placed near one of the nodular points, which is nearly always the case, violent vibrations will be caused by the rocking couples inherent in the construction of the engine.

These couples are even greater than those inherent in an ordinary triple-expansion engine, because the small weight of the high-pressure piston at the fore end of the engine is replaced by the much greater weight of the low-pressure cylinder. However, these difficulties may be overcome entirely, or at least greatly reduced, by adopting engines with four cylinders and four cranks. Two methods of construction, which differ chiefly in the relative position of the cranks to each other, come here into consideration. In one of these methods the cranks are so arranged that in each pair at each end of the engine they form an angle of 180°—viz., stand exactly opposite each other, while the two pairs themselves stand at an angle of 90°. The two small cylinders are placed at the ends, and the two large cylinders between them in the middle of the engine.

The construction of such a quadruple-expansion engine is represented in sketch at fig. 6. The steam enters at cylinder I., and passes through the cylinders II., III. and IV. successively. The cranks of the successive cylinders stand, therefore, always at an angle of 90° to each other. The steam

might also be made to take a different course through the respective cylinders; but care should always be taken that the two heaviest cylinders, or the heaviest piston weights, are placed in the middle—viz., between the two lighter cylinders.

Fig. 7 represents the arrangement of a triple-expansion engine of this system with two low-pressure cylinders. The advantages of this construction are, first, that the forces produced by the reciprocating masses of any two adjoining cylinders are nearly balanced—viz., that the algebraical sum of the existing vertical forces is approximately equal to zero; and secondly, that only very small rocking couples can be produced. In most cases counterweights may be either entirely dispensed with, or will only require to be of such a size that there will be no difficulty in their adoption.

In case the engine is placed very near the nodular point, it is very desirable to balance the couples that might be formed. As the balance-weights need not be very large, it is admissible to let them rotate, without any fear of injurious horizontal components being produced. The simplest way of balancing the respective forces is to fit a balance-weight on the periphery of the wheel of the turning gear, with which every engine is furnished; and also a disk of suitable diameter on the fore end of the crank-shaft. This disk, which also bears a balance-weight on its periphery, can always be easily fitted and offers no danger to the engine-room staff.

In order to reduce the counterweights for these disks to a minimum, the weights which work at the two outside cranks of the cylinders I. and II., fig. 6, must be smaller in a certain ratio than those working at the two inside cranks of the cylinders III. and IV. The determination of the exact ratio of these weights to each other mathematically is rather complicated, but supposing that the weights which act on the crank II. are in the same proportion to those which act on the crank IV., as the weights which act on the crank I. are to those which act on the crank III., and further supposing, for the sake of simplicity, that the counterweights are arranged at the same distance (*a*) from the center lines of the outside cylinders as these cylinders are distant from each other, then the weights of the moving parts of the outside cylinders must be 0.823 times the corresponding weights of the adjoining inside cylinder.

If the counterweights for a four-cylinder engine of this construction of 7,000 indicated H.P. are calculated according to this rule, the respective weights will be 2.68 tons and 2.45 tons. It is, however, here supposed that these counterweights are fitted at a distance from the center of the crank-shaft equal to the radius of the crank. Although these weights are considerable, yet they might be applied to an engine of the above size without hesitation.

In the case of an engine with four cranks, the counterweights might, however, be avoided altogether, and all possible existing forces and rocking couples be balanced, if it be not made a condition that all the four cranks are placed at an angle of 90°. This arrangement will suffice for all requirements of a completely balanced engine. The masses acting on the outer cranks form, so to speak, the counterweights for the forces acting on the inner cranks. If, therefore, the weights of the pistons for the outer cylinders are chosen rightly, and their respective cranks are put at the proper angles, such an engine will always work without producing vibrations in the ship. The position of the four cranks to each other might vary considerably. For instance, the position of the two inner cranks may be chosen optionally, and the weights of the pistons of the outer cylinders, as well as the position of their respective cranks, be arranged accordingly.

The two inner cylinders must, in this arrangement, be furnished with the heaviest pistons, and it will, therefore, be best, also, to place the largest cylinders in the middle. If the cranks for the two cylinders III. and IV., fig. 6, are placed at an angle of 90° to each other, the arrangement shown at fig. 8 might be adopted for the cranks. The relations of the moving weights for each cylinder are marked at each crank in brackets, as shown.

The movement of the forces acting on the crank-shaft during one revolution will, in this arrangement, vary more than would be the case if all the cranks were placed at an angle of exactly 90° to each other. These circumstances are, however, not so unfavorable as might at first appear, and differ but little from those of three cylinder engines, if the cylinders have only the proper diameters. The cranks belonging to the cylinders I. and II. might also be placed at an angle of 90° to each other. The arrangement of the remaining cranks consequently required will be seen in fig. 9.

Any number of arrangements similar to those represented at figs. 8 and 9 might be made and used in practice. It will be easily seen that, if the angle at which the cranks of the cylinders I. and II. are placed to each other is made smaller, the angle for the cranks of the two other cylinders will also have to be smaller.

In the case of a triple expansion engine with four cylinders, as shown at fig. 7, the relative positions of the cranks to each other will be symmetrical, and therefore the motion of the engine will be still more even. This principle may also be applied to engines with three cranks only, when the moving parts of an imaginary fourth cylinder are replaced by a counterweight at the after end of the engine. This counterweight may, as already proposed for four cylinder engines, be attached to the wheel of the turning gear. By using such a counterweight and adopting the proper angles for the cranks, the vibrations of already existing steamers can be greatly reduced, or even entirely obviated.

From the foregoing observations it will be easily seen that in designing a ship it is of the greatest importance to determine, in the first place, the position of the nodular points.

If the weights of a ship were distributed equally in the direction of the longitudinal axis, and the moment of inertia of any cross-section at any distance from their common axis were always the same, then the position of the nodular points would be 0.2242 times the ship's length distant from its ends.

This value is, however, greatly influenced by the more or less equal distribution of the weights, and I may, perhaps, have the honor to lay before you the results of my experiments and observations on this head on a future occasion.

TRIALS OF H. M. S. "HORNET."

A NOTEWORTHY series of trials of the new torpedo boat destroyer the *Hornet*, built and engined by Messrs. Yarrow & Co., of Poplar, were brought to a highly satisfactory conclusion recently by the completion of the official trials of the vessel, which took place off the mouth of the Thames.

There was recorded in the *Times* of November 22 ult., under the heading of "Water-Tube Boilers in the Navy," the experimental trial of a new boiler on the water-tube principle patented by the builders of the *Hornet*. The boiler, as stated, was one of eight with which the *Hornet* was to be fitted, and from the tests to which it was then subjected it gave evidence of capabilities as a steam generator for sea-going purposes which have been practically realized within the past month. The trials of this new type of vessel have been in each case attended by Admiralty officials.

Preceding the final official trial of the vessel, a first private preliminary one was made on January 31 ult., which was a great success, as she then proceeded to sea with only four boilers on board, being half the boiler power, in a comparatively light condition, when a speed of 23.3 knots was realized, the boilers working at a very moderate air pressure, and supplying with ease all the demands made upon them for steam. On February 23, the whole of the eight boilers having been fitted on board in the mean time and the vessel completed, she proceeded on a trial which, in its results, is memorable, marking, as it does, the realization at sea of the highest steaming speed yet attained by any vessel, as she in three out of seven runs on the Maplin mile made over 30 knots, the average speed for the seven runs being 28 knots, the engines at the time making nearly 400 revolutions a minute, steam being maintained in the boilers at 172 lbs. pressure a square inch, with a little over an inch of air pressure. On March 7 a further trial was made with the vessel over the same ground with very fair success, the engines developing a total indicated power of about 4,000 horses, with 1¼ in. of air pressure in the stokeholds; but one of the guide-bars of the engines having begun to heat, it was deemed advisable to return and proceed with the vessel at a moderate speed to her moorings. On this occasion the vessel was rather deeper in the water than her normal loaded displacement.

Matters having been adjusted by the docking of the vessel, her manganese propellers fitted, trim regulated, and engines in sea-going order, she left Gravesend on Monday last and proceeded down the river. On reaching Thames Haven, about 10 A.M., a three hours' continuous trial was begun under forced draft, during which six runs on the Maplin mile were made, with the following results in speed attained:

Runs.	1	2	3	4	5	6
	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
Time	2 17.6	2 6 4	2 16.6	2 6.8	2 8	2 7.8
Speed in knots	26.16	28.48	26.35	28.39	26.03	28.16

Thus a mean speed was attained of 27.313 knots. On the completion of the mile runs, the vessel, for the remainder of

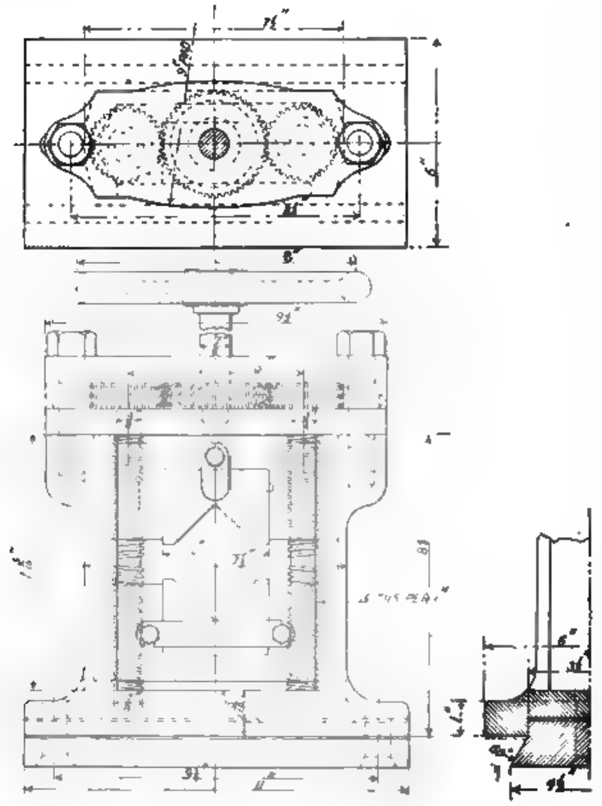
the trial time, was run straight out into the North Sea, and on the expiration of the three hours was found to have realized a mean speed over the whole of the time of 27.628 knots, the engines having run at a mean of 388.3 revolutions per minute and developed a total of 4,000 indicated H.P., with steam at a pressure of 169 lbs. per square inch and 1½ in. of air pressure.

The *Hornet* is 180 ft. long and 18 ft. 6 in. beam, and at a mean draft of 5 ft. has about 220 tons displacement. Her propelling engines are twin triple compounds of Messrs. Yarrow's ordinary design for torpedo boats. The cylinders are 18 in., 26 in. and 39½ in. in diameter respectively, the piston stroke being 18 in. Her boilers are eight in number, having a total heating surface of 8,216 sq. ft. and a grate surface of 164.8 sq. ft., the furnace-bar length being 6 ft. 6 in. They are arranged in two stokeholds in groups of four, each pair of boilers having a funnel, thus giving four funnels to the vessel—the first ever fitted with so many in the British Navy—which with the exception of cowls for carrying air into the fans—horizontal ones in the case of the *Hornet*—and for other ventilating purposes are the only important projections above deck aft of the forward turtle back.

The main features of the Yarrow water-tube boiler having been popularly described in the issue of the *Times* before referred to, we have, in conclusion, to direct attention to what appears to be the very great advantage offered by the water-tube boiler of the Yarrow type over those wherein bent or curved tubes are adopted; as it is a matter of common knowledge that impurities in the feed water of a boiler are far more likely to adhere to the inside surface of a tube that is tortuous than of one in which the water of evaporation has a straight unchecked course in its circulation through the tubes as in the Yarrow boiler.—*London Times.*

PIPE CHUCK FOR LATHE.

We illustrate a pipe chuck which has been designed and is in use at the shops of the Philadelphia & Reading Railroad, at Reading, Pa., with a 16-in. Bement lathe. It is very frequently necessary to hold a pipe in order to cut the thread



PIPE CHUCK FOR LATHE, PHILADELPHIA & READING RAILROAD.

in the lathe, and for this purpose it is necessary that the chucking should be central with the spindle. The chuck which is illustrated is arranged so that the center line of the screws which draw the jaws together is exactly in line with the spindle of the lathe when set on the carriage, or, of course, if it were to be used with a larger lathe blocking up would be required, and with a smaller lathe it would probably have to be set upon the ways. The construction is clearly shown from the engravings. There is a hand-wheel over the center carrying a spur gear which meshes in with two others that are keyed to the stems of screws that are ⅞ in. in diameter at the bottom of the thread, ⅛ in. outside the thread. These threads are rights and lefts, the rights being at the upper end, so that the jaws are moved together and grasp the pipe. The jaws are removable, and are held in position by the latches, which are shown on the front face of the side elevation, so that pipes of varying sizes can be held. As the two screws draw together quite evenly, there is no vertical thrust in either direction and no wear in this respect. The gears are housed in beneath a cap, which holds them down in position and at the same time excludes all dust and dirt. The device is a simple one, and will undoubtedly be suggestive to others from which they can arrange a similar device for lathes of their own when the necessity may arise.

PRESSED STEEL UNDERFRAMES.

The Leeds Forge Company have recently added to their establishment a large and important department. It consists principally of a large building 12,000 sq. yds. in area, of substantial construction, and already fitted with a good deal of costly plant, for the most part designed especially for the work in view. This work is the stamping out of the various members which go to make underframes, bogies, etc., for rolling stock. We believe that the idea of reducing the weight of rolling stock on railways was first impressed on Mr. Fox, who has worked out the details of the system, by seeing a heavy man on a light bicycle. He argued that if a vehicle weighing perhaps no more than 83 lbs. would carry a man weighing 200 lbs. on the high road, railway trucks and carriages could be constructed with a somewhat closer approximation of the ratio of weight of load to that of the vehicle carrying it. In the case of the bicycle the ratio is, as will be seen, as 8 to 1; the weight of an ordinary railway truck designed to carry 8 tons is about 5 tons, 18 cwt., which gives a ratio of 1⅓ to 1. No doubt Mr. Fox recognized that the conditions applying to a bicycle carrying a man and those of a railway truck carrying its load are vastly different. However this may be, Mr. Fox considered there was a large margin within which he could work, and the results, as he has brought them out in tangible form, seem fully to confirm his conclusions. It may be interesting here to give some figures from estimates which have been formed as to the world's consumption in railway underframes. In England there are (or were at the time the estimate was made) 20,000 miles of railway, and the published statements give 548,000 underframes, or about 27 to the mile. Taking the whole railway mileage open at the time for the whole world, excepting England, so far as obtainable from published statistics (principally "Bradshaw's Railway Manual"), and taking the number of underframes of rolling stock at only 10 to the mile, and adding the sum so obtained to the known number of underframes on English railways, we get a total of 3,150,000. We assume the death-rate at 5 per cent.; there would be 157,500 new underframes required each year, or over one every 10 minutes. The plan upon which the new works have been laid out is to produce one underframe every 10 minutes.

It has no doubt often puzzled engineers unconnected with railway matters—for instance, the designers of steel torpedo boats, how it is that wood has managed to hold its own for so long in the construction of underframes. There are, however, virtues in wood which do not appear on the surface, and difficulties in the way of application of iron and steel on a wholesale scale. Mr. Fox, having taken the bicycle as his prototype, naturally elected to stand or fall by steel. He came to the conclusion that where members had to be joined they must be riveted together by means of a flange stamped in one with the solid metal, and that the use of angle irons riveted on must be abandoned. It may be said generally, therefore, that Fox's system consists mainly of flanging steel plates into various forms. The most usual required for underframes is that of a plain channel section with ends, or, in other words, a trough form; so that while in cross section the form differs little from that of an ordinary rolled channel bar, the blank is solid, flanged all round, both at the sides and ends. In this way, when two bars are joined together, nothing further is required for attachment but the necessary bolts or rivets; the latter being preferable, as nuts are liable to shake loose. The abandonment of angle irons as a means of attachment enables a considerable saving to be made in weight, and greatly reduces the number of separate pieces. It will be evident that it is by no means necessary that all joints should be made at right angles; when required, they can be made at various degrees of inclination.

PRESSED STEEL IRON CAR, MADE BY THE LEEDS FORGE COMPANY.

Where pieces which may be called angles, or which correspond to angles, can be used with advantage in building up the patent underframes, they are of large size, and may be formed out of plates only ¼ in. thick. In this way a saving is made of 50 per cent. of weight over that required for similar angles or knees formed in the usual way; at the same time there is no loss of strength. The system of pressing thin plates also adapts itself very readily to the combination of separate parts; thus, a wagon or carriage headstock may be made which can be riveted in the flanges of every other piece abutting upon it; in this way there is no occasion for the numerous angle irons, gussets and knees used in the more ordinary forms of construction. With respect to the strength of frames produced, it may here be stated that a small bogie frame, weighing 728 lbs., was recently tested, and stood a load of 24 tons without deflection; it was not until the load was increased to a total of 55 tons, 10 cwt., 2 qr. that deformation took place. The flanges then were bent or deformed, but there was neither crack nor flaw in the metal, nor did the riveting give way, and the parts could with ease and trifling expense be restored to their original form. This test was made by dead weight piled on the bogie. Another test of a similar nature was made, in which a pair of American bogies, each weighing 812 lbs., had a dead weight test-load on the center-bar of both bogies of 130,186 lbs. There was no deflection or deformation of any kind, the test gauges pointing to zero. The bolster springs were pressed close, metal to metal.

This system of building up frames admits of duplication of parts being carried to great perfection. A design being once decided upon, the manner in which the various parts are molded insures exact similitude, and the necessary holes are spaced with precision by means of templates. The manufacturers claim that frames can be built up to given dimensions with the utmost nicety, the various parts square and true with each other, and the dimensions over all as exact as if the pieces had been planed to size. The result is a structure which cannot be destroyed unless by violent collision or similar accident. In ordinary cases, however, if a bar become bent it may be put right by an ordinary smith; but, supposing a piece is bent out of shape so badly as to become useless, the makers undertake to supply a duplicate that will fit properly if the other parts are uninjured. From the character of the material, fractures are extremely unlikely to be produced even by collision, as the flanges can be beaten down close without cracking.

Those who have had experience of the pressing of metal sheets into hollow forms will easily understand that it is no easy matter to obtain parts such as those shown in our illustration with a gauge of metal uniform throughout. To stamp single trough sections would be a comparatively easy matter, but this would necessitate the riveting on of angle attachment pieces, a mode of procedure which is diametrically opposed to Fox's system, and the avoidance of which constitutes the great merit of his plan. The rectangular trough, therefore, has to be provided with ends stamped out solid at one operation with the rest. To encompass this, the die and mold, or "the tools," as they are called, have to be very nicely proportioned. Great exactitude, which can only be attained by much experience, has to be observed in the formation of the upper edge of the mold. This has to be of a contour which will cause the proper flow of metal to the part required. It is further necessary that the edges of the trough, which is to form a member of the carriage frame, should be fair and even, without one part standing up above another, otherwise a certain amount of machining, in the shape of sawing off or otherwise, would be necessary, and this would naturally add greatly to the expense.

The strips of steel, bar and plate, which form the blanks from which the troughs are pressed, contain exactly the amount of metal required for the finished piece. They are placed in a furnace and brought to the required temperature for pressing—viz., a fair red heat. They are then placed flat upon the female mold in the hydraulic press, the table of which rises until the dies have duly entered the mold, thus forcing the flat plate into the required shape. If one were to attempt to perform such an operation as this, say, with a piece of paper or a sheet of cold metal, the surfaces would be doubled over each other, supposing, of course, the material were sufficiently tough for rupture not to take place. In the present case, however, were there any doubling over of the metal, there would be obviously a weak place; but doubling over is absolutely prevented, for the clearance or space between the die and mold is exactly the same as the thickness of the metal strip, which in turn is exactly the same as that of the finished part. It will be evident, therefore, that there can be no folding over of the plate, in place of which the metal is made to flow in due proportion, so as to fill every part of the

space between the tools, which space is of exactly the same extent as that of the cubic capacity of the blank. The proper flow of metal is induced, as already stated, by the contour of the top edge of the mold. Whatever doubling-over tendency there may be is converted into end pressure in lines parallel to the surface of the part, or, as it may be termed, an "upsetting" or "jumping" action.

It may be pointed out that naval architects are becoming strongly alive to the virtues of bending over or flanging plates in the building of steel ships, in place of riveting on angles or reverse bars; hydraulic machines of large size are now being manufactured for this purpose, especially in the case of bending over floor-plates and transverse divisions for double bottoms. It is impossible, however, from the nature of the case for shipbuilders to have at their command such beautifully designed machines and such accurately worked-out practice as that in use at the Leeds Forge.

It should be stated that for many years past the Great Western Railway have used steel underframes for rolling stock, but these are not pressed in the manner followed by the Leeds Forge. There is, however, an important plant at Swindon for constructing these underframes, and the success attained with them shows that steel is a suitable material for the purpose.

The Leeds Forge Company on this principle are the same in general design. The railway companies specify the dimensions of some of the parts, and that circumstance naturally goes far to determine the weight; but the Leeds Forge Company very emphatically state, as the result of experiment and experience, that by proper distribution and formation of the parts, and by the use of suitable material, the section of the bars may be such as to reduce the weight of an underframe very considerably, as compared with underframes of wood, iron and steel, built up in the ordinary way with channel or other bars, fastened together by means of angle irons. Details in regard to this matter will be given later. The number of separate pieces used with Fox's system is said to be less than one-half that required with well-made underframes of the present ordinary types. In all types of wagons with these underframes the tares are less than half the gross weight, including the wagons and full load, whereas in wooden underframes the tare seldom approaches so low as half the gross weight. The reduction in weight of an underframe made on this principle is about 25 per cent., as compared to frames of ordinary channel steel, in which the attachments are made by angles, gussets, knees, etc. The decrease in weight is not, however, the only advantage, for there is an increase in strength and a reduction in parts, making the underframe simpler to construct, as already referred to. An instance of this may be given in the case of a foreign railway, where competitive designs were invited from various makers, the order going to the Leeds Forge. In the stock which the Company proposed to use the underframes were made of steel, and consisted of 68 pieces. By the adoption of the pressed steel underframes the number of pieces was reduced to 13; the weight at the same time was reduced from 19 cwt., 3 qr., 21 lbs. to 13 cwt., 7 lbs., a saving of between 6 cwt. and 7 cwt., or about 35 per cent. In addition to this the number of rivets was reduced from 282 with the old arrangement to 104 with the new; while the number of rivet-holes was brought from 680 to 220.

Fig. 9, page 262, is an illustration of a 20-ton truck, with bogies which have been designed to compete with the American Diamond bogie design, which was supposed to be the type that possessed the virtue of lightness above all other forms of construction.

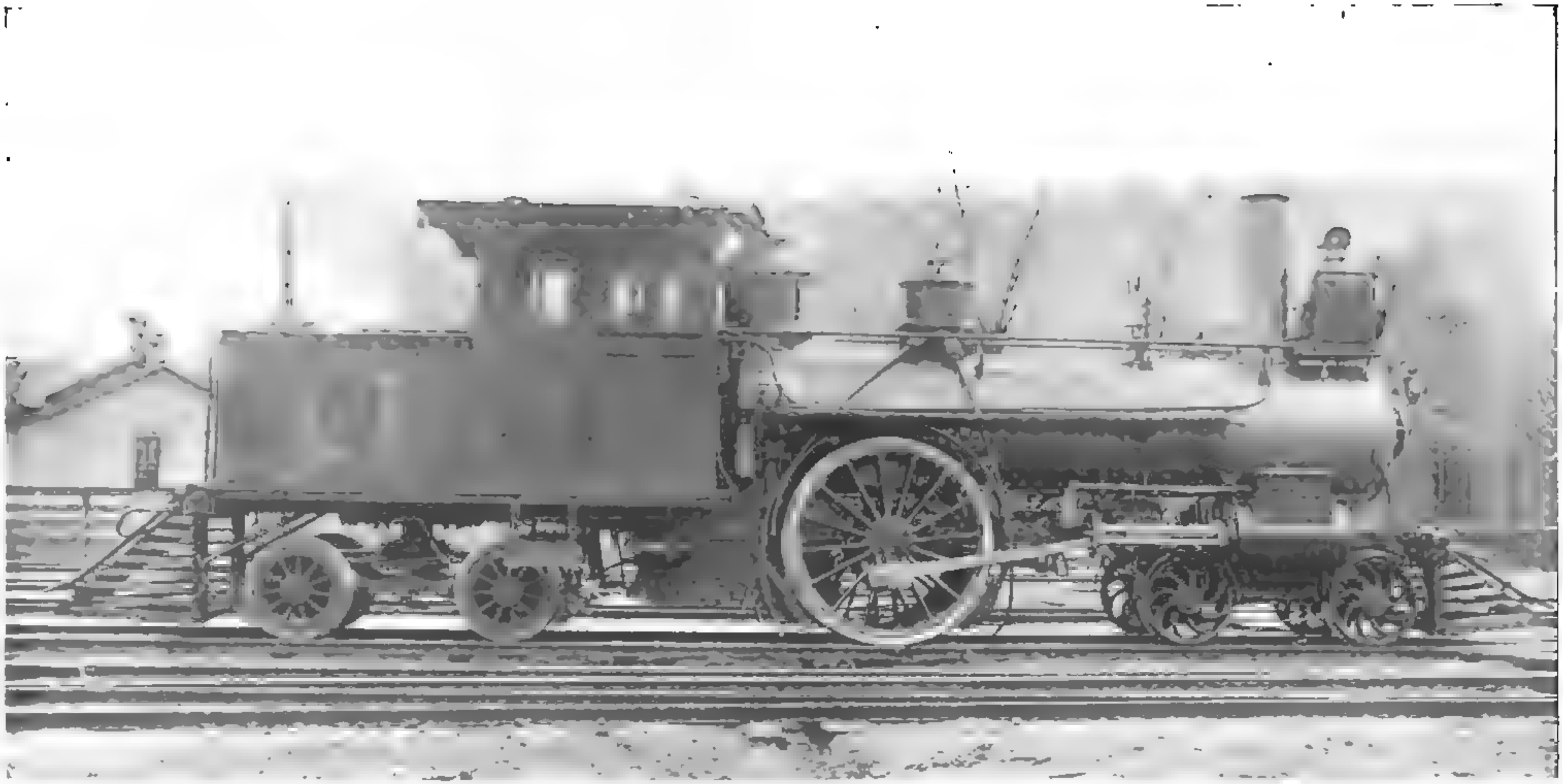
One of the earliest to appreciate the merits of pressed steel underframes was the late Sir George Berkley, President of the Institution of Civil Engineers, he having introduced the system largely in his work for the Natal Government railways. The pressed steel bogie frames have been in use on the Natal Government Railway since 1890, and orders for a fresh quantity were repeated a short time ago; the gauge is 3 ft. 6 in. On the Mexican Railway, of which Sir Alexander Rendal is the Consulting Engineer, the pressed steel bogie frames have also been for a considerable time used.

English railway engineers have been reproached with having lost sight of the important question in railway economics, of the amount of non-paying load that is hauled by the locomotives. Our critics say that, having a long purse to draw upon, our engineers have not troubled themselves to do the best that could be done from an economical point of view. There is no doubt that in the United States engineers have been more successful in reducing the tare of wagons in terms of the full load. The conditions of traffic in this country are different to those of America, but even in the United States it is questionable whether the size of goods wagons has not been carried to an undesirable extent, and that very frequently very big trucks are run with comparatively small loads, so that the actual weight of wagons as compared to the actual weight of goods carried is sometimes in excess of that of English railways. In this country we are bound to a great extent to our smaller goods wagons by the nature of sidings, etc., which are not suitable for long wagons, but there are signs of change in this respect, and the Manchester, Sheffield & Lincolnshire Railway are working in this direction. Indian railway engineers have of late turned their attention largely to this question of dead load, and they look forward to a reduction in the weight of rolling stock to enable them not only to carry the present traffic, but to provide for an increase of traffic for many years to come, using only the existing power and the present permanent way. The Leeds Forge have constructed for Sir George B. Bruce a number of carriage underframes and bogies, which have been sent to India, and also some open platform wagons, made entirely of pressed steel.—*Engineering.*

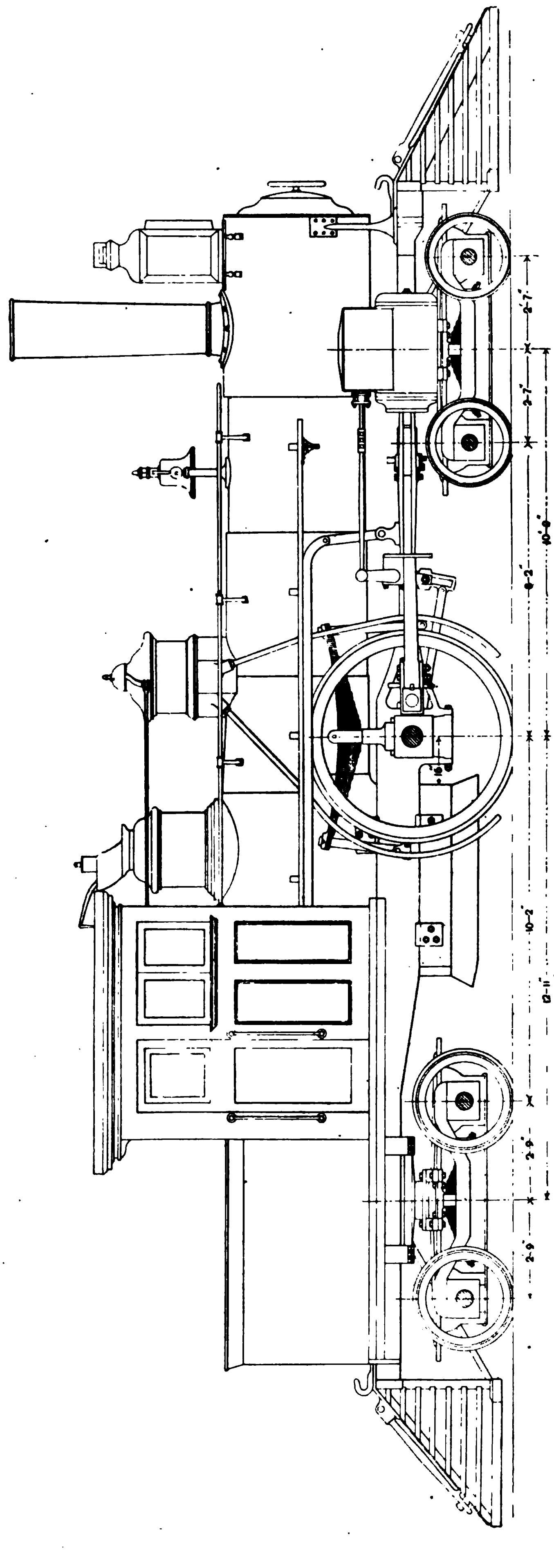
LOCOMOTIVE FOR LOCAL TRAFFIC ON THE FLINT & PERE MARQUETTE RAILROAD.

Mr. T. J. Hatswell, Master Mechanic of the Flint & Père Marquette Railway, has some engines in service hauling local passenger trains between Saginaw and Bay City, in which only one pair of drivers is used. Our full-page illustration on page 264 is a reproduction of a photograph of one of the engines. The side elevation shows the detail of construction. These engines are doing remarkably good work in the passenger service between the two points named, hauling trains ranging from two to six cars on fast schedule time. The line running from Saginaw to Bay City is a branch, and is operated by separate engines from those working the main line traffic. The engine, as shown, is a double ender. It is easily handled, and has the neat appearance in running of all single-driver engines, giving perfect satisfaction in the service for which it was designed. The following is a list of dimensions and detail of the engine:

Kind of fuel used	Bituminous coal.
Gauge of road	4′ 8½″
Total estimated weight of locomotive in working order, including two men	80,000 lbs.
Total weight on driving-wheels	40,000 "
" wheel base, including tank	29′
Distance from center of main driving-wheels to center of cylinders	10′ 7¼″
Transverse distance from the center of one cylinder to the center of the other	6′
Diameter of H. P. cylinder and stroke of piston	15″ × 22″
Horizontal thickness of piston over piston-head and follower plate	5″
Kind of piston packing	Dunbar.
Diameter of piston-rod	2½″
Size of steam-port	1⅛″ × 14″
" " exhaust-port	2½″ × 14″
Greatest travel of slide valve	5½″
Outside lap of slide valve	1⅛″
Inside lap of slide valve	1/16″
Throw of upper end of reverse lever from full gear forward to full gear backward, measured on the chord of the arc of the reach rod-pin throw	14½″
Sectional area of opening in each steam pipe connected with cylinders	15.9 sq. in.
Sectional area of opening in each exhaust pipe connected with cylinders	23.75 sq. in.
Diameter of driving-wheels outside of tires	67⅛″
" " front truck-wheels	30″
" " tank "	33″
Size of main driving-axle journal, diameter	7″
" " truck axle journals, diameter	5″
" " main crank-pin journals, diameter and length	3½″ × 3½″
Length of driving springs, measured from center to center of hangers	5′ 7½″
Description of boiler	Belpaire.
Inside diameter of smallest boiler ring	3′ 7¼″
Material of barrel of boiler	⅜″ steel.
Thickness of plates in barrel of boiler	⅜″
Kind of horizontal seams	Lap triple riveted
" " circumferential seams	" double "
Material of tubes	" welded iron.
Number " "	183
Diameter of tubes outside	2″
Distance between centers of tubes	2¾″
Length of tubes over tube plates	11′ 1″
" " fire-box	4′ 5″
Width of fire-box	2′ 10″
Depth " "	5′ 2½″
Water space, side of the fire-box	4″
" " back of fire-box	4″
" " front of fire-box	5″
Material of outside shell of fire-box	Steel.
Thickness of plates of outside shell of fire-box	⅜″
Material of inside fire-box	Steel.
Thickness of plates inside of fire-box	⅜″
" " " back end of fire-box	⅜″
" " crown plate	⅜″
Material of tube-plates	Steel.
Thickness of front tube plates	¾″
" " back tube plates	½″
How crown plate is stayed	Stay bolts 4¾″ pitch.
Diameter of dome	30″ outside.
Height of dome	2′ 10″ inside.



SINGLE DRIVER LOCOMOTIVE FOR LOCAL PASSENGER SERVICE ON THE FLINT & PÈRE MARQUETTE RAILROAD. DESIGNED BY MR. T. J. HATSWELL, M.M.



SIDE ELEVATION OF SINGLE DRIVER LOCOMOTIVE FOR LOCAL PASSENGER SERVICE ON THE FLINT & PÈRE MARQUETTE RAILROAD.

Maximum working pressure per sq. in	130 lbs.
Kind of grate	Locomotive shaking grates
Width of opening between bars	½"
Grate surface	12.51 sq. ft.
Heating surface in fire-box	84.49
" " of the inside of tubes	702.38
Total heating surface	786.87
Kind of blast nozzle	Single.
Diameter of blast nozzle	3½"
Smallest inside diameter of chimney	16"
Height from top of rails to top of chimney	12' 9"
" " " " " center of boiler	6'
Distance from center to center of truck wheels of tender	5' 6"
Water capacity of tank (in gallons of 231 cu. in.)	1,200.
Coal capacity of tender or fuel-bin	2 tons.
Total wheel base of engine and tender over all	42' 1"

ELECTRIC POWER INSTALLATIONS IN ENGINEERING AND IRON WORKS.

At the meeting of the Cleveland Institution of Engineers on the 9th inst., at Middleborough, Mr. J. Phillips Bedson, of the new Cleveland Wire & Iron Works, Middleborough, read a paper by Mr. D. Selby Bigge, of Newcastle-on-Tyne, on this subject. The following is an abstract: The author said that electricity had for many years come under the notice of civil, mechanical, and general engineers; but, as a rule, this had been in connection with lighting. For some four or five years electricity had been employed as a motive power in connection with mining operations, such as hauling, winding, pumping, ventilating, coal-cutting, drilling, and other minor uses. The application of electric power had, therefore been confined chiefly to what might be called long-distance transmission; in some cases over many miles, as in the case of mining work or traction. The general tendency had been to consider the application of electric power in those cases only where the power had to be conveyed a considerable distance. The writer desired in his paper to draw the attention of engineers to short-distance transmission or concentration of power. In order fully to grasp this idea, he would take the case of any large engineering works in which the motive power was derived from a number of scattered and auxiliary steam-engines, which in some cases were used for driving shafting in fitting shops, and in other cases were applied to various machine tools, winches, traveling cranes, overhead cranes, hot saws, cold saws, rolls, forge blowers, punching and shearing machines, straightening machines, planing machines and the numberless other apparatus which were daily employed in engineering establishments. Cases were often found in which numbers of pumping and shearing machines were driven by means of belts and pulleys, receiving their power through long lines of main shafting and countershafting. In many cases the boilers necessary for producing steam for all these engines, were situated at a considerable distance from them, and the steam had to be conveyed through long lengths of pipe. The boilers, instead of being all concentrated together in one battery, were scattered about the works. Such were the conditions daily met with when looking through engineering establishments.

The writer then set himself to show how short-distance electric power installation could be advantageously adopted, and what great economies could be realized by a concentration of all that scattered power.

1. Taking the case of separate engines for driving individual machinery, it would readily be admitted by all engineers that much better steam economy could be obtained from the employment of one large highly efficient engine than from a large number of small engines, which for many reasons were not of so efficient a character, the steam consumption in each of the small engines being proportionately four to six times greater than it would be in a large engine of a triple-expansion condensing type.

2. Taking the case of a machine shop driving off shafting, there was considerable loss incurred in transmitting power through long lines of mains and counter shafting with all the attendant gear wheels, bearings, pulleys, belts, etc., this loss varying from 20 per cent. up to 60 per cent. of the power transmitted.

3. The disadvantage of having boilers at long distances from the engines they had to drive did not need to be recounted, nor the inconvenience of having boilers scattered about, and the inefficiency of working at a low pressure.

All these disadvantages could be obviated by a well-considered application of electric power. The writer proceeded to demonstrate the way in which this could be realized. The first thing would be to find out the individual power of all the steam-engines in the works and the total H.P. Having arrived

at the unit of power to adopt, the next thing was the site that the generating plant should occupy. If in the neighborhood of a river or other water, the plant should be placed in such a manner as to afford every facility for condensing purposes, and if waste furnace gases were available the plant should be placed so that the boilers would derive full benefit from gas firing. The site need not necessarily be in the works at all, as distances not exceeding half a mile, or even a mile, were, electrically speaking, not of great importance when compared with the advantages to be derived from gas firing and condensing. The next question to be considered was what form of engine and dynamo should be adopted for generating the electric power. The boilers should work at high pressure—150 lbs. up to 180 lbs —the engine should be triple-expansion, and be coupled direct to a dynamo capable of giving out a power equal to the full output of the engine. He would assume this to be 500 H.P. With dynamos of this size and power there would be three types of engines to select from, running at three different speeds: First, a horizontal Corliss engine, running at 80 revolutions per minute, and coupled direct to a dynamo, of which the armature would form the fly-wheel of the engine; second, an engine of the triple-expansion marine vertical type, also coupled direct to the dynamo, and running at a speed of 150 to 180 revolutions a minute; and, third, an engine of the high speed electric lighting, or Willans type, and running at a speed of 300 revolutions per minute. In any of the above-named cases the electric power should be generated for not more than 1¼ lbs. of coal per indicated H.P. The current would then be led from the generating dynamo to a main switch-board in the engine-house itself, and by circuits would be brought back from the various motors about the works to this one central board, in which measuring instruments would be placed so that the attendants in charge could see at a glance what each individual motor or set of motors in the works was doing at any time of the day or night. The cables from the main board should be taken to minor distributing boards, or sub-stations, if the works were of any very great extent, and further branched off again to the different motors. The cables, in some instances, would be run overhead, and in others in culverts or channels underground. It was most important that the motors, etc., should be kept as dry as possible. Where necessary each machine tool could be provided with its own electric light.

In works not exceeding 800 yds. in length, the efficiency of such a plant would be made up as under: Loss in main generating dynamo, 7 per cent.; in mains, 3 per cent.; in motors, 15 per cent.: total efficiency, 75 per cent.

With an ideal electric-power installation there would be self-contained electric machine tools, in which the motor would be embodied as part of the machine; but in existing works this was difficult to realize, and the method was either to drive by belt on to existing fly-wheels, or else couple the motors direct by means of gearing.

The very small loss in distributing the power through cables was a matter which must be evident to all engineers, when compared side by side with long lengths of shafting or of steam-pipe, in which condensation and loss of power were bound to take place. Considerable economy in wages could be effected by the application of electric power, especially in works where there were a number of boilers scattered about. These scattered boilers could generally be entirely done away with, and replaced by one or two large high-pressure boilers adjoining the generating plant.

In establishments where the work was of an intermittent character, electricity was particularly applicable. Under present circumstances large numbers of outlying machines were kept constantly running whether in operation or not. These took almost as much steam when running light as when doing their work. The amount of coal wasted during the year in keeping idle machinery running was very considerable. A large proportion of this waste could be avoided by the use of electric motors which could be switched on or off instantaneously.

Another very practical application of electricity was the driving of all forms of cranes and winches. Almost every modern crane in America was electrically driven—at any rate in those places where electric current was available.

A further advantage of electric power was the small size and weight of the motors themselves and their foundations.

As to the cost of the up-keep, for installations of 300 H.P. and upward, it would be 5 per cent. per annum on the capital outlay, though with care and attention it should not exceed 3 per cent.; the bearings, brushes, and commutators were the only wearing parts of a dynamo or motor. There was hardly any depreciation in the copper cables, and copper would generally find its value. Switching apparatus required seldom renewing if properly constructed.

Where electricity had been applied to old works, and the generating plant was not of such a character as would be found in an entirely new works, economies from 30 to 60 per cent. had been obtained in the coal consumption, entirely due to the electrical distribution of the power. The writer thought that it was almost the duty of an engineer who wished for economical working results to study the application of electric power when extending or remodelling old works or building new ones.

The writer mentioned that three large works in Middleborough had already adopted or were adopting the use of electricity as a motive power, and several other manufacturers had the matter under consideration. He expected that within the next five months nearly 1,000 H P. of electric power would be running in Middleborough, and this was far in advance of what had been done in any other town in this country. As regarded the application of electric power, the American and continental manufacturers were perhaps far ahead of ours. In Belgium and Germany large works were operated exclusively by electricity, and had been running for three years with very remarkable results as regarded economy. There was no great difficulty in constructing dynamos of almost any size. The largest that had been constructed was a 2,000-H.P. multipolar dynamo, built by the General Electric Company, of New York. It was employed in running the Intramural Railway at the World's Fair, and was coupled direct to a compound condensing Corliss engine. It weighed 35 tons, and the efficiency obtained was 96 per cent.—*The Engineer.*

MEETING OF THE MEMBERS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The Use of Water-Tube Boilers in the Navy.

By Walter M. McFarland, Past Assistant Engineer, U. S. N.

Having been honored by the Committee which is in charge of these monthly meetings of the Society with an invitation to prepare a few remarks to serve as a basis for a discussion of the subject of water-tube boilers, with special reference to their use in the Navy, I have pleasure in complying; but must state at the outset that the request came at a time when pressure of other matters did not give me the leisure necessary to go into the subject as carefully as I might have wished.

In this matter of water-tube boilers I shall confine myself to the type known as tubulous or coil boilers, merely mentioning that years ago a water-tube boiler, invented by Engineer-in-Chief Martin of the Navy, was in use for some years and gave satisfaction. This, however, was a shell boiler, and its weight was about the same as that of fire tubular boilers, so that it does not come properly in the category we propose to discuss.

It may be stated at the outset that coil boilers possess certain advantages which recommend them for use in naval vessels, and would make their adoption a certainty but for one or two features. From their successful use naval designers have had their ultimate adoption in mind and have watched the development with the greatest interest. In our own Navy extended experiments were made by Boards of Naval Engineers under the direction of that great engineer Isherwood on the Herreshoff boiler, so that full information was possessed in this respect. Experience with them, however, was not such as to warrant their adoption for use in large vessels.

The advantages offered by coil boilers for naval vessels may be stated as follows:

Reduction of weight of boiler and contained water.
Adaptation to very high pressures.
Safety against disastrous explosion.
Rapidity of raising steam.
Freedom from injury due to forced combustion.
Facility in renewal when worn out.
Against these advantages is to be set:
Greater injury by corrosion.
More care required in feeding.

As a matter of fact, if it were not for the trouble due to corrosion, there would be hardly anything to be said against the coil boiler, for the difficulty sometimes due to feeding is a matter of training of the attendants. A friend recently wrote

me in regard to the boilers of the *Monterey*, where each fireroom has two Ward boilers and one cylindrical: "One feedpump can be made to supply both Ward and Scotch boiler in battery, but every chump who calls himself a water tender can't do it."

It is hardly necessary to elaborate the advantages, but it may be remarked that the reduction of weight is the greatest. For the last 10 years the demand on the designer of naval machinery for increased power on reduced weight has been growing stronger, and although forced draft does materially reduce the boiler weight, it has not been an unmixed blessing. When we reflect that coil boilers weigh less than half as much as cylindrical ones for the same power, and that they can be forced to any extent without danger of injury, we see how desirable the coil boiler becomes.

As in the case with many other improvements in steam machinery, the Navy has followed rather than led outside practice. The reason for this is not hard to understand when we reflect that the officers charged with the carrying out of Government work have not the free hand of those in civil life. A designing engineer frequently has unusual opportunities given him by the fact that some yacht owner demands exceptional speed, and is willing to sacrifice almost everything to attain it. Such a case would offer a splendid opening for the trial of a tubulous boiler.

In 1885 the late Admiral Simpson of the Navy, who had been President of the Naval Advisory Board, in an inaugural address as President of the Naval Institute, made the remark that the great necessity for improvement in naval vessels was in reduction of weight of machinery, and that he thought it lay in the direction of using Herreshoff boilers rather than those of the ordinary shell type. He doubtless selected the Herreshoff boiler for the reason that some launches with this boiler had been used in the Navy, and it was the only one with which he was familiar. In that Society it was not considered the proper thing to discuss or criticise the inaugural address of the President, so that no reply was made to the remark at the time, as could very readily have been done; but at an adjourned meeting which I attended, Passed Assistant Engineer Kafer, then attached to the Bureau of Steam Engineering, did discuss the subject in an informal way, and he remarked that the Engineer-in Chief of the Navy, who was then Mr. Charles H. Loring, who has since been President of our Society, was fully alive to the promise of tubulous boilers, but that he was not willing to stake his professional reputation on their success by powering a vessel of any size with them. He was perfectly willing, Mr. Kafer said, to advocate their adoption experimentally on a small vessel, but it must be understood that it was an experiment; and he called attention to the fact that it was a very easy matter for people who had no responsibility attending their recommendations to advise certain lines of action, while the ones on whom the responsibility came were necessarily compelled to be more conservative.

Not very long after this a test of a Ward launch boiler was made by a Board of Naval Engineers. Mr. Ward having offered his boiler for test and agreed to defray the expenses, and this test showed excellent results, both as regards economy of evaporation and power for a given weight. Herreshoff boilers had been used, as I have already said, in naval launches for some time, but they were not entirely satisfactory in every respect and had not been generally adopted. The test of the Ward boiler gave information of a type of boiler adapted to all the requirements of naval purposes, and in 1888 several of them were fitted to naval launches. Their success was very marked, and since that time no new boats have been built which have not been fitted with coil boilers, although other types besides the Ward have been used, a number of Towne boilers having been fitted, and also one or more each by Roberts and Almy. Our experience with the Ward boiler has been more extended than with any of the others, and I have heard a number of officers who have had experience with it in different portions of the globe testify uniformly to their entire satisfaction with it.

About 1888 the Navy Department made a contract with the Herreshoffs to build the *Cushing*, and the design in every respect was left to them. At first it was the intention to use Herreshoff boilers, but subsequently that firm, having acquired the control of the Thorneycroft patents for this country, requested and obtained permission to use Thorneycroft boilers in the *Cushing*. In the early part of 1890 the *Cushing* was tested officially, after having been given a number of private tests by the builders. The official test as well as the others were very satisfactory, and showed the boilers to fulfill the requirements of the case with great satisfaction. In the *Journal of the American Society of Naval Engineers* for 1892, Chief Engineer Isherwood has written an article about the *Cushing*, which gives an extended account of the boat and all her various trials.

In the fall of 1890 a series of tests of one of the boilers of the *Cushing* was conducted by a Board of Naval Engineers under the Presidency of Chief Engineer Loring, and a large amount of valuable information obtained. A copy of the report of this Board was published in the report of the Bureau of Steam Engineering for 1891.

In 1888 Engineer-in-Chief Melville of the Navy urged upon the Secretary the importance of experiments on a large scale, to determine the suitability of tubulous boilers for use as a part or all of the boiler power of our naval vessels, and in accordance with his recommendation the Secretary sent out an invitation to all the builders of coil boilers in this country, inviting them to submit plans and prices to meet specifications which had been prepared by the Department. Some 15 or 20 replies were received, and in 1889 an invitation was sent to the makers of those boilers which appeared adapted, asking them to suggest a time when they would be ready to have their boilers tried. Four of the firms who had previously replied acknowledged the receipt of this letter, but only two of them actually submitted boilers for trial, Mr. William Cowles and Mr. Charles Ward. A boiler made by each of these gentlemen was tested by a Board of Naval Engineers under the Presidency of Chief Engineer Loring, and the report giving the results was published in the report of the Bureau of Steam Engineering for 1890.

As a result of this competitive test the boiler submitted by Mr. Ward was adjudged to have given the best performance, and in accordance with the terms of the proposition under which the tests were made a contract was concluded with him for supplying boilers for the U. S. S. *Monterey*, to furnish the steam for 4,200 H.P. in triple-expansion engines. The trial of the *Monterey* took place in 1892, and the boilers gave a very good account of themselves, the engineer officers who attended the trial speaking in the highest terms of their creditable performance. The trial of the *Monterey* was not in every respect a complete success, because the H.P. of the machinery fell slightly below that required by the contract, and in explanations as to the cause of this deficiency there was some difference of opinion. There was no means of telling certainly how much steam was supplied by each kind of boiler (there being two single-ended cylindrical fire tubular boilers besides the four Ward boilers). The naval engineers who were present attributed the failure to attain the H.P. to lack of skill on the part of the firemen, while I have understood that engineers connected with the Union Iron Works, who built the vessel and all the machinery except the Ward boilers, thought that the trouble was partly due to the coil boilers. They thought this was not due to any defect in the boilers themselves, but to the fact that their position in the ship was such that it was difficult to clean the fires and keep them in the best possible condition, and that on this account there was a falling off.

It is to be noted in connection with this trial that a very high air pressure was used at times, as much as 4 in. of water, and although some leaky tubes were developed in the cylindrical boilers, the coil boilers showed no signs of injury in any respect, and after the trial were as tight as before.

This comprises the actual experience in use in our own Navy up to date. The *Ericsson*, a sister torpedo boat to the *Cushing* with a few changes, now building at the Iowa Iron Works, is to have Thorneycroft boilers, while four third-class torpedo boats for the *Maine* and the *Texas* are to have Mosher boilers.

In a design elaborated at the Bureau of Steam Engineering last year, coil boilers in connection with cylindrical are to be used in supplying a quadruple-expansion engine. The coil boilers will furnish steam at 250 lbs. to the high-pressure cylinder, while the cylindrical boilers will supply steam of about 150 to 160 lbs. to the first receiver. The type of coil boilers to be used has not yet been settled, as it is the policy of the Department to permit the contractors to make the selection in the first instance subject to approval.

Last summer at the International Engineering Congress a paper was read on the subject of coil boilers in general by Mr. Ward, and in the discussion of that paper I remarked that it appeared to me that the most important question in connection with coil boilers was their longevity. Being composed entirely of tubes of small diameter and quite thin, it naturally follows that corrosion will be a very important factor in their usefulness. Mr. Ward has informed me personally that some of his boilers which have been used on Western rivers, and have never been exposed to the influence of salt water in any way, have already been in service for over 10 years and are still in excellent condition. There are also some in use on yachts, I believe, which have had six or seven years' service, and the revenue cutter *Manhattan* has a boiler which was put in in 1888, I believe, and is still in good condition.

The launch boilers that we have used in the Navy have been satisfactory in respect to longevity, as none of them have as yet given out, except in an occasional tube here and there, which were easily repaired. The *Monterey*, of course, has been too short a time in service to have any question of longevity raised The boilers of the *Cushing* have now been built at least five years, and they are in excellent condition, and have shown no signs of pitting or other serious deterioration.

The question of corrosion assumes a somewhat different phase for coil boilers from the same phenomenon for shell boilers, because in the latter the tubes form a relatively secondary part of the boiler, while in the former they practically are the boiler; and, as has been repeatedly pointed out, a leaky tube in a shell boiler can be plugged while steam is up; but this cannot be done in the coil boiler. There is no reason why the tubes of a coil boiler should deteriorate any more rapidly than those of a shell boiler, and in many types they ought to last longer because thicker.

Mr. Ward has stated that one of his boilers built nearly 14 years ago has lost only one tube, while a number of other boilers have been in use for six or seven years and given no trouble. Mr. Roberts also states that the first of his boilers built about 15 years ago has never given any trouble from corrosion. It is probable, however, that most or all of these boilers have been carefully kept free from the deleterious action of salt water, although a good many of these boilers are fitted in yachts about New York.

I might, then, sum up our experience with coil boilers by saying that as regards lightness, rapidity of raising steam, safety against disastrous explosion and safety against injury by excessive forcing, they have given entire satisfaction.

The experiments on the Ward and Cowles boilers in competition, and those on the Thorneycroft boilers of the *Cushing* and the Ward boilers on the *Monterey* show conclusively that coil boilers will stand any amount of forcing without injury, as these were all subjected to air pressures of 2 in. and over for long periods without a single leak being developed. We also made a severe test of a small Towne boiler at one of our Navy Yards by running it for several hours under forced draft, then hauling fires as quickly as possible and turning a stream of cold water on every part of the boiler from a hose, so as to get the full effect of sudden contraction. Not a leak developed anywhere.

With regard to longevity, it is as yet too early to speak, but such experience as we have had leads us to believe that with proper care to guard against corrosion they should have a reasonable life.

In this connection it is worth noting that the Belleville boiler has been in use in the French Navy for at least 10 years, and the experience with it has apparently been so satisfactory as to lead the English Government to place an order for a set of these boilers for the large English cruisers *Powerful* and *Terrible*, which are to have about 30,000 H.P. each. The Belleville boiler differs very materially from the coil boilers invented in this country and all others invented abroad, in having its tubes of very large diameter and much thicker than those in any other coil boiler. The tubes are generally about 4 in. in diameter, and the lower row are about three-eighths of an inch thick, and no tubes are less than .20 of an inch. This undoubtedly accounts for the long life of these boilers, as it is manifest that a trifling bit of corrosion which would go clear through a thin tube will only affect these thick ones half as much, and will still leave them serviceable for a long time. The great trouble with the Belleville boiler, compared with most other coil boilers, is its weight. We shall doubtless shortly have some valuable data in regard to this particular boiler from the experience with the fast express steamers on the great lakes, which are to be fitted with boilers of this type.

The number of coil boilers is almost legion, and every inventor brings out some change in his own type at frequent intervals. I presume it would be safe to say that nearly all that are designed with any regard to a good circulation will give good results, and such has certainly been our experience with those thus far used in our Navy. It is curious to observe, however, how ideas change in regard to what is necessary to secure a good circulation. Mr. Ward has always claimed that you could put your down current almost anywhere if the feed went into it, and that, of necessity, if the water went up in some tubes it must come down in others. For awhile Thorneycroft, Mosher and some others provided down cast pipes entirely outside the boiler, but they have now abandoned that plan.

I feel that I must apologize for the incompleteness of this paper, but I would refer those who desire an elaborate investigation of the subject to the paper by Mr. Ward, read before the International Engineering Congress, and published in the *Proceedings of the Division of Marine and Naval Engineering and Naval Architecture*, and to papers read last year and this before the Institute of Naval Architects in England, by Mr. J. T. Milton, Chief Engineer Surveyor to Lloyd's. The subject is a thoroughly live one, and I am glad the Society has taken it up. A number of our members have much greater personal knowledge of the characteristics of particular types of these boilers than the writer, and it is to be hoped that during the discussion on this subject they will give the Society the benefit.

DISCUSSION.

Mr. Boyd: Several years ago I was engineer at the Atlantic Works, and we put in the first Belleville boilers that were put in in this country. They were put in the yacht *Shearwater*, and the objection then raised was their weight. We had no very good comparison at the time, but those boilers performed very successfully. One winter they went on a cruise to the Caribbean Sea, and for about three weeks they were not free from salt water. When the boiler was opened I went down and examined the tubes carefully. There was no deposit of salt, and there were no apparent defects in the boiler. She was sold about two years ago by her owner, and I think has been running in New York since then. The owner of the vessel, Mr. Forbes, built a yacht of about double the capacity, and he put in two Belleville boilers and then two small donkey boilers. Those boilers have been in use now three years, and so far as any internal or external examination can be made, they are apparently as good as the day they were put in. We are so much interested in the subject in Boston that we are investigating it, and probably will undertake the building of Belleville boilers there under the Belleville patents. From our experience, without going into detail at all, we think it possesses qualities that are not possessed by any other multitubular boilers. The experiments made by the Government on the *Shearwater* were made to test the rapid evaporative efficiency with 100 lbs of steam only. The Belleville system is to carry from 200 to 250 lbs., and then through a reducing valve to reduce the pressure in the engine. I think they are to carry 250 lbs. on their boilers and 180 to 200 lbs on the engines. I am very sorry that I did not think of coming to-night because I might have brought some dates in regard to the time the boilers have been in use and the repairs on them. But nothing, I think, except the renewal of gaskets has been expended on any of the boilers I speak of. I am sorry to say I cannot say how much these boilers weighed per H.P. I think, in the report published by the Navy Department, that they gave fully all the weight that was credited to the boilers, and my impression is that it weighed between 15 and 20 per cent. of what the Scotch boiler would. The claim is that when the pressure gets to 200 lbs. the weight of the boiler is very much less.

Mr H. De B. Parsons: I have had a little experience with water-tube boilers, especially in yachts. I am a believer in the water-tube types, although my remarks would probably appear as if the water-tube type was not the best. Yacht boiler service is probably the hardest for the boilers of any marine service. The consequence is that the boilers in a yacht of the water-tube type do not usually last more than two years. At the end of the second year some trouble is developed. I had a yacht that had a water-tube type boiler of the Herreshoff pattern. It was not the old-fashioned Herreshoff, fed at the top, but it was the boiler that they got out immediately after that. The first of their type fed at the bottom. The boiler lasted about two years, and the third summer was replaced with a boiler of another design. That boiler was absolutely worthless; and my services were retained to find out the trouble, and I condemned the whole thing on the ground that it was too small for the engine. The boiler designer had so much confidence in his boiler that he stretched the point of H.P. per square foot of grate, and in consequence we could not do anything with it. We put the boilers on. The yacht was supposed to run with forced draft, and I took it over the four-hour trial trip as specified, and nothing was ever seen of the water. I trusted to the Worthington duplex feed pump and to the engineer's experience, who had been with the yacht about three years, as to the speed the pump could run at, and we let the pump go at that speed, every now and then feeling a little cock on the pump to see if it was pumping water. The engine apparently was taking steam all right and exhausting all right; and when our trial was over, about three or four minutes after the engine was stopped, the water came back and stood about an inch above the bottom of the glass gauge. During the four hours it was absolutely out of sight—never came back at all; you couldn't get it back. Everything blew steam. The boiler was condemned.

In another case a yacht was furnished with a Ward boiler which wore out in about three or four years. I was retained,

and the owner put in four boilers in place of the one large Ward boiler, of the Roberts type, against my wishes. The grate surface was increased from about 56 to 64 sq. ft. with four boilers. Result: the fire room was so hot you could not stay in it; and as the boilers backed up against the engine-room, you could not stay in the engine-room. The boilers would give no steam at all. The engine was three-cylinder compound, 20 in. × 24 in. for the high pressure, and it took more steam than the four boilers could give. The consequence was that the yacht was laid up all summer and never used. The boilers were put on the dock and replaced with the old Scotch boiler which I recommended originally. Although the grate surface is only 50 sq. ft., the Scotch boiler gave plenty of steam to run the engine.

The result of my experience from these cases and others is this: If you are going to use a water-tube type of boiler, you have got to have plenty of grate surface. They need more grate surface than the other type. I know they will stand forcing, according to the tests; but my experience does not indicate that they will give in ordinary practice the H.P. per square foot of grate that you can get out of the old-fashioned boiler. The reason of that is probably that there is no storage of steam, no steam space, and no energy stored in hot water, and the consequence is when the steam once gets down you cannot bring it up very well; the engine will take it faster than it is made, unless you have boilers of ample size. My first effort in boiler designing was an absolute failure. It was such an effort as most young men make in attempting to design something which they know very little about. I undertook to design a coiled boiler. My ignorance led me to use tubes of different sizes. Result: the small tubes evaporated faster than the larger ones, and the consequence was that there was some sort of circulation—I don't know what. But the boiler acted very strangely. There was absolutely no water to be found anywhere in it. There was steam in it, but where the steam came from I do not know. Being the designer, I had to sit up with my creation, and it was no pleasant day that I spent with it on the Hudson River. I was very anxious to go back to the dock and get ashore and leave it, but they told me to keep on. They had not said the word more than twice when there was a terrible rattling inside and we could do nothing with it. The minute we would start again the small tubes apparently sucked everything out of the large ones and reversed the operations that were designed to take place. The water was forced back apparently into the large down-draft tube and there it stayed, and as fast as it came out it was evaporated and the steam in volume held it back. The result proves to my mind that you need a large water tube if you are going to use one for the sake of economy and for the sake of comfort, and that the circulation should be well designed so as to work as designed.

Mr. Kafer: The design of water-tube boilers has been to make steam on very little weight. If we were satisfied to make it as we were thirty or forty years ago there would be no water tubes in existence. But the problem now is to get maximum power from minimum weight, and that is the problem for the water-tube boiler. The great difficulty in the water-tube boiler is to get it perfectly accessible. With tubes readily removable repairs can be easily made, and it should be made to last a reasonable length of time—not to last the length of time that a Scotch boiler will last. I do not know of any one boiler in the market that will fulfill all the conditions and yet have maximum power for minimum weight. The great difficulty with designers has been to crowd too many small tubes in the space allotted to them, and for that reason they want to get rid of the weight of water. That is the chief advantage of the water tube boiler having small tubes. The Belleville boiler is a very excellent boiler to operate under natural draft. But if you will take a box coil and have a hot fire under the lower coil and burn 50 lbs. of coal per square foot of grate you will find trouble before you get up to the upper end. That is one reason why a Belleville boiler will weigh more than a Scotch boiler, or nearly as much as a Scotch boiler of the same relative H.P. under forced draft. The Belleville boiler must be operated at a lower rate of combustion than that at which the Scotch boiler can operate with perfect safety. With reference to the other types of boilers—Yarrow and Thornycroft and others—they all depend on natural circulation. It is well known that a boiler of that type will hardly evaporate as much water per pound of coal under ordinary conditions as the ordinary Scotch boiler. But if you could have an engine on the outside and force the water through the tubes, so that you knew when the shaft was turning the water was going through the tubes, you would accomplish perfect circulation, and yet you might have the tubes in such a position as not to have corrosion when the vessel was laid up.

Mr. Isherwood: The merits of the water-tube boiler have been very clearly stated in the paper read by the secretary, and its principal merit, of course, is the lighter weight. The vital defect about it—one which has been very little alluded to heretofore, if known at all—is that it is impossible to obtain with it the same economic evaporation that you can obtain with the ordinary shell boiler. That is to say, if you make the two boilers—the pipe boiler and the shell boiler—both with the same grate surface and the same heating surface, and burn the same quantity of coal in both per unit of time, it will be found that the pipe boiler gives about 10 per cent. less economic evaporation. That is to say, if one boiler will evaporate 10 lbs. of water to the pound of coal, the other will evaporate but 9 lbs. Of course there is a reason for this, and I think it is very easy to see. It arises from the air leakage in the case of the water-tube boiler. In the case of the shell boiler, no air, no exterior air, can get mingled with the gases of combustion. The only air that enters is that entering through the furnace in the ash-pit and over the bed of coal on the grate through the holes in the furnace door. Every particle of air that enters into and mingles with the gases of combustion after they have passed over the bridge wall reduces the economic evaporation of the boiler very largely. In the first place, it cools those gases so that they do not have the temperature upon the heating surfaces that they should, consequently cannot give the evaporation; and, in the second place, it requires a certain quantity of heat to force those gases out against the resistance of the atmosphere, the opposing resistance at the top of the chimney, which is also at the expense of the heat of the coal. The two things put together will make that difference about 10 per cent., as I have stated, of the economic evaporation of the two types of boiler. There is no practical way of excluding the air leakage; and while I am on this subject I will say that there is just the same difference of 10 per cent. in boilers set in brickwork. You take the ordinary boiler with straight tubes and the shell and you set it in brick-work. You have a brick furnace. You will never get the same economic evaporation from it as with a shell boiler—that is, the Scotch form of boiler—for the simple reason that there will percolate through the brick work setting a certain quantity of air very much larger than any one would suspect, and that reduces the economy of the evaporation. In the early days of my practice as an engineer I was confronted with the fact that all the boilers set in brick masonry gave a lower economic evaporation than those not so set. In other words, that the interior fired boiler gave a higher evaporation than the exterior fired boiler. I made quite a table of the results from all the boilers of the two types that I could obtain. A very great many of those experiments were made by me, and I took the mean of them and I found that they approached the 10 per cent. very closely. I did not at that time know the reason. I had not the faintest idea of it. I thought it was something in the type of boiler. But really I could not reconcile it. I had the same grate surface, heating surface and combustion of coal in both cases. I could not see why this difference should be for a long while. But the difference was there as a practical fact, and it was caused, as I afterward ascertained, by what I have stated—the in-leakage of air into the gases of combustion, cooling them and requiring more expenditure of heat to expel them from the chimney.

Now, let us see what, in a ship, a difference of 10 per cent. in the evaporation of the boiler means. It means a good deal more than appears on the surface. To develop the same power for the same length of time, you have got to carry 10 per cent. more coal in your bunkers. If you have a vessel that carries 1,000 tons of coal in its bunkers it has got to carry 1,100 tons if you replace the shell boiler with the pipe boiler. Now, that difference of 10 per cent. of course becomes more important as you carry more and more coal and make longer and longer voyages. That difference goes very far to counterbalance the saving of weight with the water-tube boiler. Of course upon the land, where the weight is of no importance, you simply lose your 10 per cent. of fuel. But on a ship you not only lose that, as far as cost is concerned, but you have got to carry this extra weight, and if you do not carry it you have reduced the steaming efficiency of your vessel that much.

In addition to this in-leakage of air, the radiation from the water-tube boiler is very much greater than from the shell boiler. In the case of the shell boiler the temperature is that of the water inside of the boiler; that is, the temperature which is on one side of the shell, the atmospheric temperature being upon the other. In the case of a water-tube boiler the temperature of the gases of combustion is upon one side of the shell or casing, and the same temperature of the atmosphere on the other. The radiant heat in a vessel with a water-tube boiler is intense compared with the radiant heat from the ordi-

nary shell boiler. Those are facts that have to be met, and we have to account for them in designing boilers. For small vessels, launches, torpedo boats, and that class of vessels, you have generally but one boiler, and you have plenty of air circulation around it where it can be kept clean and well cared for. If any repairs are to be made, it can be hoisted out by a few men on the dock and put back again. But it is a very different thing when you put an enormous power into a vessel and boilers of this type. As a general rule, they will probably last, under ordinary circumstances of sea practice, from two to three years. It is difficult to understand that they can last longer than that. I am aware that some boilers, like the *Cushing's* and a few others, have lasted much longer; but why? They have been protected by zinc. Large quantities of zinc have been put into them according to the practice of the Thornycroft people and others building those boilers. That answers very well. But it is very expensive. The simple question is, Will you pay in zinc or will you pay in boiler? But you have got to pay for the thing one way or the other. In the case of a water-tube boiler with its thin outside casing of sheet iron, apart from the great loss of heat by radiation, there comes the difficulty of repairing. Any person who has examined those boilers and has seen the wilderness of small tubes in them, the impossibility of getting at any one of them or at their joints, will see that to repair one you have got to lift it out as a general rule. You cannot find the place. It may happen to be an outer or an inside tube, and you can see it; but if it is any of the interior tubes that leaks it is impossible to tell. In the case of a vessel that is a very serious piece of business to have your boilers break down all at once at sea. What is required is durability. That is a very important point. In the case of the ordinary Scotch boiler, in which iron tubes or steel tubes will last from two to three years, you can always see when your tubes are going. It is only a matter of eyesight, and they are easily replaced. They are a straight tube. Your fireman can replace them with very little trouble. But it is a very difficult thing in a water-tube boiler in a large vessel, where you have to break all the connections, piping, everything, and actually lift the whole affair out, amounting to almost a reconstruction each time you attempt to make extensive repairs. Of course these are facts which will probably develop as these boilers come more and more into use, and I have no doubt they will come into use, but not permanently. I have very great doubts of that for anything like sea-going vessels. But, like all other physical subjects, we must depend on practice and experience for that purpose. The tubes of an ordinary tubular shell boiler will last from two to three years, and there is no imaginable reason why they should last any longer in the water-tube boiler, if as long. The old Martin boilers which we had in the Navy had vertical water tubes placed in the tube-box. When those tubes were made of iron the lower 6 to 9 in. began to rust out in less than a year. You had to commence renewal at about that time, and continue it constantly until they were all renewed. The upper part of the tube was not touched. They were as good as new. The lower part was entirely gone. Now, why was it? Simply this: the lower portion of the tubes was in ashes—the ashes from the coal deposited in that—and every time the boilers were cooled down there was a deposit of moisture on the surface of the tubes which trickled down into this ash and made a very corrosive lye, an alkaline solution which corroded the tubes very rapidly. Now, why should not this result take place in, we will say, the Thornycroft boilers, in which the lower parts of the tubes are vertical? They are inaccessible for cleaning; the ash and soot must collect and they must be damp at times, and there must be the same alkaline solution there that there was in the Martin boiler, only much more so, and why should it not produce the same effect of eating out the tubes? These are all matters which future experience will have to solve, but they are very important ones, and lead us not to be too sanguine on the success of the new class of boilers.

With regard to the Belleville boiler, that was first used in the French Navy as far back as the days of Napoleon III. Its use commenced then. It was put, I think, in some half-a-dozen vessels, and I do not know that the type of boiler has been modified at all since. That which was put in the *Shearwater* was exactly the same as used in the earlier French vessels, and every one of them was taken out. A number of years ago I was in France and visited every French dock-yard, and I conversed very freely with the French engineers stationed there. Their opinions to a man were against that type of boiler. They were all removed from the vessels. Since that they have been reintroduced, and with what success it is impossible for me to say, because the most instructive of such trials rarely ever reach the world. I mean the failures. We hear all about the successes, but we hear nothing of the failures; and that is one of the great difficulties we have in engineering, in getting at the correct statement of facts. Nevertheless, I think that the Navy should make large experiments on this type of boiler; build one of that type, try it thoroughly, stop at no expense on it, because the subject is well worthy the cost. But thus far we have not had any such experiments, not complete enough or extensive enough to enable us to form a real opinion upon it.

As regards the forcing of that type of boiler, it can be forced to any extent from the simple fact that the tubes are curved so that any difference of expansion does not injure the joints, but the tube merely curves or straightens more, while the joint remains unaffected, nor is the tube at all injured. In the Scotch boiler we have a straight, rigid tube, and whenever the temperature of that tube becomes much greater than the temperature of the water which surrounds it, it is sure to expand and force the tube ends through the tube-plates. That has always been the result when the attempt is made to force combustion in a Scotch boiler beyond 46 or 47 lbs. of coal per square foot of grate per hour, which is the maximum rate of combustion possible with it.

In the British Navy the attempt was made to go beyond that, and, as all the world knows, it was a failure. The boilers leaked a deluge the moment that rate of combustion was passed. Then it was stated that by means of a species of ferrules they succeeded in overcoming that difficulty. Well, that was one of the little romances that are sometimes used to cover a failure. The truth is, the so-called ferrules did no good whatever, and the proof of it was the fact that they were obliged to lessen the rate of combustion down to a point somewhere in the neighborhood of from 40 to 45 lbs., which is now the maximum at which those boilers are perfectly safe, while above it they are not.

These are about all the facts we have to go by; and what we want now are careful experiments made by competent people here in America, where we know the persons and can witness the processes. The subject is a very important one indeed, and I would be the last one to throw cold water upon it. Still, I think the chances of ultimate success are much better when all the difficulties are known in advance and can be calmly and deliberately provided against.

Mr. Eckley B. Coxe: I wanted to ask whether anybody knows what effect the increasing or decreasing the amount of coal consumed per square foot of grate surface, or the burning of coal, has on the relation of the temperature of escaping gases; and secondly upon the relation of the carbonic oxide and the free oxygen. From experiments I have made lately I am satisfied that a great many of the wonderful divergences that are found in experiments on boilers are due to the fact that that relation between the free oxygen and the carbonic acid and carbonic oxide varies very considerably. I have recently, in an experiment, had as high as 15 per cent. carbonic acid and no carbonic oxide. I have also had as much as about 9 per cent. carbonic acid and 8 per cent. of free oxygen, and still nearly 2 per cent. of carbonic oxide. Now, it is not necessary to tell anybody that that will make a good deal of difference in evaporation. The reason that I ask the question is that I cannot find much about the subject anywhere, and I would like to know about it. The question with me is this: When you are burning 30, 35 or 40 lbs. you force that up to 45 or 50 lbs., how does the relation between the CO, the CO^2 and the free oxygen change?

Mr. Isherwood: I think I can answer the question in part—that is, the relation of the different gases of combustion depends altogether on the thickness of the bed of coal upon the grate surface. If the thickness of the bed of coal does not exceed 12 in. in one direction and 6 in. in the other, it will be found that there is practically a perfect combustion with coal of the ordinary lump size, and that just twice the quantity of oxygen or atmospheric air has been supplied that is chemically required. If you will simply increase the depth of the coal on the grate bars you can have any proportion between carbonic acid, carbonic oxide, unconsumed air and free oxygen that you like. If you will make sufficient grate you will get the ordinary gasogen, in which nearly the whole of the carbon of the coal is converted into carbonic oxide. The temperature of combustion is entirely independent of its rapidity. The temperature of all fires at the surface of the coal is exactly the same, and you will have perfect combustion if you will keep within those limits of thickness. Good firing consists in knowing what those limits are and keeping within them. Some particular fireman or some particular watch of firemen do a great deal better than others. They carry the same steam with very much less fuel, and if you watch them you will find the reason very plainly. They have found out by practice the exact thickness of the bed of coal that gives them the maximum result, and they adhere to that. Other firemen, less observing, do not know that and violate the rule, and, of course,

make a great deal of carbonic oxide and lose a great deal of the economic effect. But the whole question is simply one of thickness of coal on the grate-bars. By varying that you can obtain just any ratio of those gases among themselves that you desire.

MR. MCBRIDE: I happen to have in my pocket the analysis of the gases of some boilers that I am running. I find that the amount of carbonic acid gas, carbonic oxide and oxygen can be varied to almost any extent you want by increasing or decreasing the amount of air admitted to the ash-pit: CO^2, 15.6; oxygen, 3.3; CO, one-tenth of one per cent.; carbonic acid, 17; one-half of one per cent. of oxygen and 5.1 of carbonic oxide. Now, in that particular case I did not have oxygen enough admitted to the ash pit, so I gave it more, and I immediately brought down the carbonic oxide to one-tenth of one per cent. This is burning a by-product which we have—logwood chips. It is nearly 50 per cent. water. Here is one of coal: Carbonic acid, 11.48; oxygen, 3.7; carbonic oxide, 1.6.

I use the Elliott gas-testing apparatus, and I make analyses of the gases every few days. I find, when the boilers are not making steam as they ought, by an analysis of the gases, a large amount of carbonic oxide going to loss and not sufficient oxygen. I can regulate it very nicely by increasing or decreasing the amount of fuel burned and by regulating the air.

MR. FORNEY: I will inquire if any one present has any data with reference to the water capacity of water-tube boilers in proportion to the quantity of fuel consumed. It has seemed to me from the general drift of the papers on this subject that some difficulty in the operation of water-tube boilers was experienced from the fact that the water capacity of the boiler was so extremely small in proportion to the old-fashioned shell boiler, and that naturally led me backward to the experience in locomotives, which, as you know, years ago were of small dimensions, and as traffic and business increased the demands upon the locomotives increased in somewhat like proportions, but the size of the boilers unfortunately did not. Now I think it has been proved a great many times in locomotive practice that the increased water capacity is a decided advantage in the operation of the locomotive and the boiler. I may relate a little experience which has already been in print, but which may be new to most of you, that I had some years ago with some engines built for a Western railroad, and which had what we called straight-top boilers—that is, there was no wagon-top for steam space, and the boilers were of comparatively small diameter. Those engines were put to work, and gave considerable trouble. They would not make steam, and they did not do their duty properly. Finally a trial was made of those engines with some others which had boilers of a larger diameter and wagon-tops of considerable height to give steam room, and they were run in competition, taking alternate trains every other day. The result was that the straight-topped boiler was very badly beaten. The method of operating was this: The large boilers, having a large water capacity and plenty of steam room, on approaching a heavy grade were pumped as full as it was possible to carry the water without working the water through the cylinders. The result was that in coming to a difficult place in the grade the engineer could shut off, or partly shut off, his water supply, and work up the hot water which was stored up in the boiler to a certain extent. This gave him a reserve power that he could fall back upon. I am aware, of course, that marine engines and boilers are not called upon to work under as many different degrees of power as locomotives; but at the same time it seems to me that a large water capacity must be a matter of considerable importance even in marine boilers, and inasmuch as the water capacity of water-tube boilers is very much less than of cylinder boilers, that it must be a matter worthy of attention. I may add that I have in my hand a letter which I have received from Mr. Hazelhurst, Superintendent of Machinery of the Baltimore & Ohio Railroad, in which he gives me the water capacity of an engine on that road. Mr. Hazelhurst says:

"It gives me pleasure to furnish you the information as to the water capacity of engine 937, which is the one that we tested on the 17-mile grade, burning some 192 lbs. of coal to the square foot of grate per hour. The results given are actual results, and are not calculated, the engine being weighed with the water at the different gauges and when full:

Capacity of Cold Water in Boiler.	Lbs.	Cub. Ft.
Full to whistle	14,400	230.93
Fourth gauge	11,100	178.01
Third gauge	10,400	166.78
Second gauge	10,050	161.17
First gauge	9,200	147.54
Steam space with three gauges of water.		64.15

"The outside diameter of boiler at smallest ring is 54 in.; height of wagon-top, 8 in.; and square feet of grate surface, 28.33."

MR. ALMY: I would say in regard to the weight of water in a tubulous boiler that has been in use some three years, that the weight of water is about 1½ lbs. per square foot of heating surface. This boiler develops 272 indicated H.P. on 3½ in. air pressure, and weighs about 5½ tons. There is trouble to maintain the water in it and carry a steady steam pressure. It runs with about 225 lbs. steam pressure, and has been run at 250 lbs. I have one boiler that I built four and one-half years ago that weighed 6,500 lbs. that had 1,400 lbs. of water. That has run about 75,000 miles, developing 140 indicated H.P., and it shows an economy over a tubular boiler of 18 per cent. in four and one-half years. In regard to the heat of the outside casing, the temperature is about 120°.

PROFESSOR HUTTON: For the credit of my old friend and colleague, Professor Trowbridge, I should like to refer, in this discussion of water-tube boilers, to a boiler which he designed and which was experimented with for some time at New Haven, and which, I think, deserved a better fate than it has received. Professor Trowbridge's coil boiler was a spiral coil, built very much upon the design of a base-burning stove. The hopper, which was intended to be a magazine feed for the boiler, came down in the middle, and this coil of pipe surrounded it. But the special feature of interest in that boiler was the forced circulation to which reference has been made. The feed pump of the boiler was not only a feed pump but a circulating pump, so that the water which was to be evaporated was kept continuously circulated in the evaporating coil, and was delivered from the top of that coil into a little bit of a steam space from which the engine took its supply. As a result of the design and that feature of forced circulation in the boiler, a little bit of a boiler, which you could cover with a flour barrel, was competent to run a 40-ft. launch, and they got a surprising amount of efficiency from it without so much reference to economy. But the quantity of steam that little machine would make was surprising. Professor Richards, of the Sheffield School, made an elaborate investigation of it. It was the aim to supply the demand for a boiler which should be practically self-managing—that would require no more attention from anybody than a base-burning stove. You filled it in the morning and you filled a magazine of water, and it was to be self-feeding and keep its level constant until somebody thought of looking at it again, with the idea that in printing-offices and other places in the country such a thing would be useful. Financial and other reasons prevented the thing from getting the opportunity that I would have been glad to see for it. But the device showed the principle of forced circulation in a coiled boiler of that type.

MR. PARSONS: The tendency of the meeting seems to be to lay stress on the earlier wearing out of the tubes in the water-tube type compared with the fire-tube type. That has not been my experience. The reason that I have given to myself I should like to state as a suggestion, as I have never seen it offered by any one in discussing the subject of water-tube boilers. While the conditions would not seem to warrant much change in the two types of boiler, the conditions are exactly reversed; the water on one side in one type, the products of combustion in the other type. We know that it is impossible to make a sheet of metal absolutely homogeneous. We know that because it does pit irregularly. If it was absolutely homogeneous, uniform in its character, there is no more reason why a pit should take place in one place than in another. But we know the metal is not homogeneous. That sheet of metal which is shown here in section is drawn into a tube the thickness of which I have exaggerated. The metal is compressed on this side and lengthened on that. If this is the fire side it meets the compressed metal. If it is the water side, the fire side meets the stretched metal, and I have attributed the earlier loss of life as due to that cause. I offer it as a suggestion. It may not be new; but I have never seen it offered before, and if I am wrong I would like to be corrected. The fire tube lasts longer apparently than the water tube, and the condition is reversed. The elongated metal in one case is next to the products of combustion and subject to the deleterious action of the gases; while if the gases pass through the tube they are acting on the compressed side. If the metal is pulled apart, and if it is granular or fibrous, the gases would have more of a chance to enter in and start the action. We all know that corrosion, once started, continues very rapidly.

MR. HENNING: I think this effect is explained much more readily on another theory. If we take a fire tube, the ashes and sulphurous acids that are formed by the moisture in these ashes deposited by the fires, or the lye alkalines that are formed, will corrode the fire tube inside. If it is a water tube, the water is inside and the fire outside and the tension side of the

metal will corrode before the other. I think that is the reason of it. I do not think that the hot-formed tube has any compression or tension on either side of the metal, because the annealing effect of the slowly cooling tube will make the material perfectly uniform on both sides.

MR. SEWELL: I would like to ask if it is well known that tubes will last longer as fire tubes than as water tubes. I saw a tube some time ago that had been in use, say 15 years, running nearly 24 hours a day. It was taken out, and you could hardly tell that the tube had been used. There appeared to be no detrimental action taken whatever. Is it absolutely known to be a fact that the statement that is made is true?

MR. FORNEY: The statement that has been made this evening is a very interesting one with reference to the reasons why water tubes corrode more rapidly than fire tubes. It has been proposed quite a number of years ago that metal under a state of tension, if exposed to any corrosive influences, would corrode much more rapidly than if it was not in a state of tension Now this shows, I think, from the way in which boilers will corrode along the caulking edge just at the point at which the tension on the metal is greatest. I remember some years ago I made an experiment by getting some rubber plates or rubber sheets which were about the thickness of boiler plates, and fastening them together precisely in the same way as boiler plates are fastened, and then subjecting them to tension. Before doing this I drew a couple of lines across the edge of the rubber, so that I could see the way in which they stretched. That, for instance (referring to a sketch), is supposed to be a section of a plate. I used a bolt instead of a rivet in this case, and held them together in that way. Now, before subjecting them to tension, I drew two fine lines across there, parallel lines, right at this point, and then stretched the rubber so as to draw them apart. When it was stretched, the lines assumed this shape. They were curved in that way, showing that the rubber at that point was subjected to a greater amount of tension than at any other point, and that it was not stretched uniformly. That action no doubt takes place in a lap joint where the plates are subjected to that tension, and, as you know, the corrosion takes place right at that point.

There is another fact that throws a little light on that, and that is the corrosion of steam chests. In locomotives, when they formerly used tallow for lubrication, which had a corrosive matter in it, the steam chests would corrode around in the corners. It would eat away into the corner of the steam chest. You are all familiar with the rapidity with which boiler stays will sometimes corrode. I think the reason for that very often is that they are under a state of great tension, and in that condition corrosion takes place much more rapidly than otherwise. The experiment would not be a difficult one to make to subject wire or other pieces of metal to tension and expose them to some corrosive fluid, and it would be very interesting in this connection.

PROFESSOR HUTTON: This affords a very good example of how possible it is to look at the same thing from different standpoints. I think that there is quite a different explanation of that phenomenon. There (referring to the sketch) is the boiler plate with tension on this side and tension on that. The tendency, therefore, of these two sheets is to produce just that effect before the thing would break. What would happen would be that there is formed naturally from the water a scale of sesquioxide of iron, and that surface is successively broken off and so a groove is eaten in. I do not think that the boiler being under tension is the explanation, but that the scale of iron being broken off is the explanation.

MR. FORNEY: That is only another way, it seems to me, of saying that in tension corrosion takes place more rapidly. I do not know whether it is chemical action or mechanical action.

MR. COXE: In the anthracite coal region we have had some difficulties that bear upon this subject. The practical fact is that you will find that, at a joint, either the rivets go or the boiler, but not both There is an electrical action. That is to say, the difference in the quality of the iron, which will form a couple. I have seen boilers with every rivet eaten. You will find where there is a good supply of sulphuric acid in the feed water that you either eat your rivets off or you eat your boiler. Very seldom both. I should say, if you examined those stay bolts that Mr. Forney referred to, you would find they were chemically different. You would find they were softer or more easily acted on than the iron of the boiler.

MR. FORNEY: Before adjourning, I would like to say a word. As announced in the notice of this meeting, this is the last one of the series of meetings held for the discussion of technical subjects, and with these meetings the duties of the Committee end. Whether the meetings will be continued in the coming fall and winter or not will remain for the members of the Society to determine. The experiment has been undertaken by some of us to find out, if we could, whether such meetings as these would be successful. I think it may fairly be claimed that at least a moderate degree of interest has attended them, and that they have received a sufficient amount of encouragement to continue them hereafter. When they were first started there were members of the Association who exercised a considerable amount of ingenuity in finding reasons to show why such meetings could not succeed; whether those reasons were well grounded or not the past experience will have to be the answer. Some opposition was also made to holding such meetings from the fact that it was thought that the non-resident members would complain that the resident members had advantages in these meetings which those who live out of town had not, and that that might result in some feeling of jealousy, and the precedent was cited that in the Society of Civil Engineers some difficulty of that kind had been found and considerable feeling had grown up. It seems to me that it is hardly fair to attribute such a feeling as that to the non resident members. I can hardly believe that any such dog-in-the-manger feeling can have any considerable existence in the membership outside New York. At any rate, there can be no sound reason why half-a-dozen members of the Society, or a dozen or a hundred members, may not meet together in this room for the discussion of subjects which are mutually interesting. The same thing is true of the people who live elsewhere. The members in Boston have that same privilege. The members in Chicago can do the same thing. I may relate a little experience I had in the Master Car Builders' Association, which has had an existence of some 20 or 25 years, and probably some 15 years ago a local Society was organized in this city which was really an offshoot of the parent Association. The meetings of the local Society have been held now, I think, for 15 years. Since then similar organizations have been formed in Boston, in Buffalo and in Chicago, and instead of their detracting from the interest or the value of the proceedings of the parent Association, which holds its meetings only once a year, I think it was universally acknowledged that the local meetings had helped to increase the interest in the parent Association; that it results in preliminary discussions of subjects which come up before the annual meetings, and that men come to them with a supply of information on the subjects which are to be considered which they would not otherwise have It is not plain to me why these same results would not occur in the Mechanical Engineers' Society. If meetings of this kind could be established in Boston and other cities wherever there was a sufficient number to form a local assemblage, the result would be that the members would have a greater interest in the Association in New York than they would have if such meetings are not held. I therefore think that these meetings should be continued and that some permanent committee should be established to take charge of them.

MR. MCBRIDE: I think it would be a proper thing to adopt a vote of thanks to the Committee for arranging these meetings this winter from which we have all derived great profit.

Such a motion was carried.

DR. EMERY: To avoid the necessity of a meeting for the purposes of organization next year, I make the suggestion that the Committee be continued with power.

MR. FORNEY: I do not think that would be judicious. In the first place, I do not mean to be on that committee another year; and, in the next place, the subject will come up before the annual meeting of the Association for full and complete discussion, and therefore arrangements for next year's meetings should be deferred until it is known what action the Society itself will take.

ELECTRIC SIGNALING WITHOUT WIRES.

IN a paper on "Electric Signaling without Wires," read before the Society of Arts recently, Mr. W. H. Preece, F.R.S., considered the subject of sending signals by means of electricity from one place to another without the intervention of any conductor, unless the all-pervading ether be termed a conductor. In 1884 it was noticed that messages sent through insulated wires buried underground in the Gray's Inn Road were read upon telephone circuits carried on the tops of the houses 80 ft. away. In 1885 it was found that currents passing in a telegraph line between Durham and Darlington produced effects in a parallel line 10½ miles distant. These results were

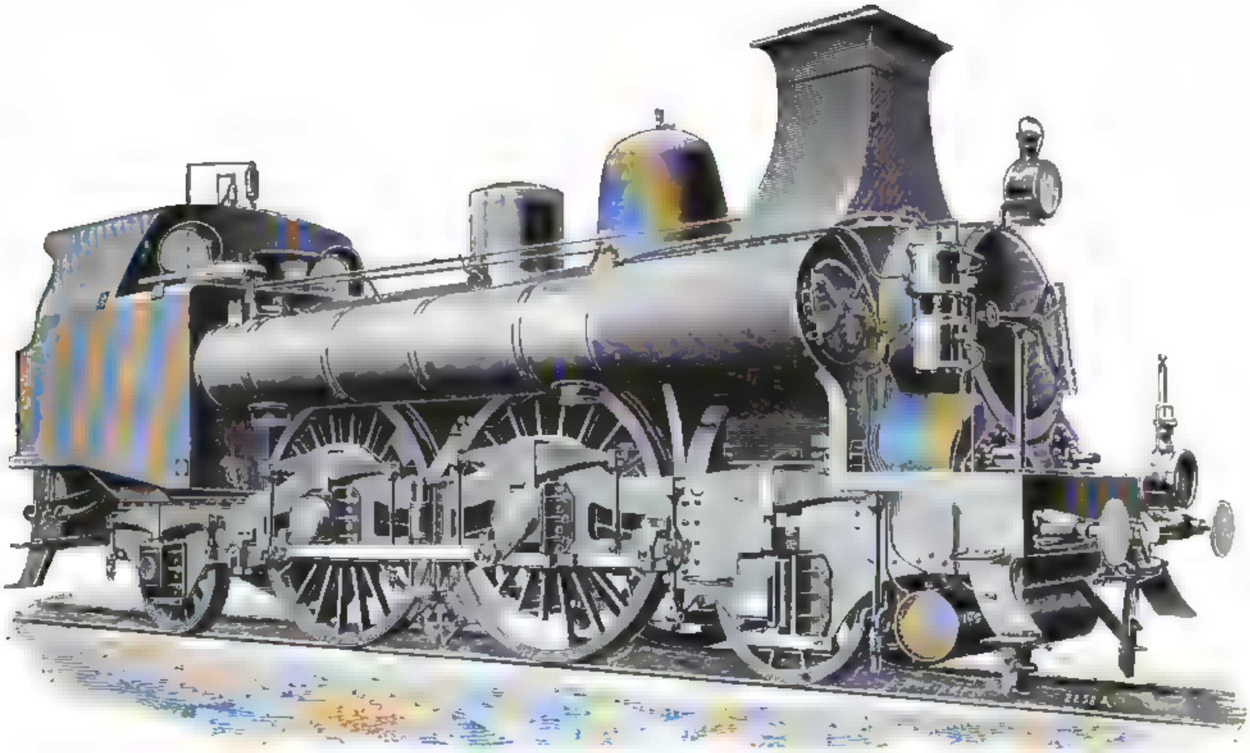
not conclusive, because it could not be proved that they were not due to accidental connections through the network of wires between those two places. In short, it was doubtful whether they were the result of induction or of conduction. But in 1886 experiments were made on parallel lines 4½ miles apart between Bristol and Gloucester, where there were no intermediate conductors to vitiate the results. Moreover, the circuits used were metallic throughout. Under these circumstances only weak disturbances were detected, though when the experiments were repeated in 1889 in the light of experience more success was obtained. The theoretical possibility of signaling without wires was thus shown, and in 1892 a practical test was made in the Bristol Channel. On Lavernock Point, near Cardiff, a copper wire 1,267 yds. long was hung on poles, the circuit being completed by earth. On the sands at low-water mark, 600 yds. from this circuit, and parallel to it, two covered copper wires and one bare one were laid down, their ends being buried deep in the sand. On Flat Holm Island, 3.1 miles away, another covered wire 600 yds. long was laid down. On the shore an alternating current (which was controlled by a Morse key) with a frequency of 192, a voltage of 150, and of any desirable strength up to 15 ampères was sent through the primary circuit. The signals received on Flat Holm on the secondary circuit produced sound and were read on a pair of telephones. By this means messages were successfully sent. The same method was tried with another island, Steep Holm, 5.35 miles away, but was scarcely successful. Disturbances were indeed perceptible, but the signals could not be read. Such experiments, in which careful precautions were taken to eliminate the effects of earth-currents, proved the possibility of signaling between England and France without any wires being carried across the Channel. But the expense would not be negligible, for at Lavernock Point a 2 H.P. engine was required to get results over 3 or 4 miles. Mr. Preece also described experiments made with parallel wires about 1¼ mile apart stretched on poles along the banks of the Caledonian Canal, near Inverness. Here, with the use of ordinary telegraphic apparatus, Morse signaling was easy and speaking by telephone possible. Mr. Preece's critics contend that his results are due to conduction through the earth. He himself maintains they are due to electro-magnetic induction. The rapidly alternating current in the primary circuit throws the surrounding ether into oscillations, and energy is radiated in electric waves. These waves spread out, as do waves of light, and, if they fall on conductors properly placed and sympathetically prepared, are reconverted into an alternate current in the secondary circuit.

TRIPLE-BOILER LOCOMOTIVE FOR THE BELGIAN STATE RAILWAY.

The curious-looking locomotive which we illustrate herewith was built in 1888 by the Société St. Leonard, of Liège, Belgium, to compete with another engine designed by the Cockerill Company, of Seraing, and exhibited by them at the Paris Exhibition of 1889. This latter, now classed as "Type 12," is less powerful than the triple boiler engine, but was nevertheless, after numerous trials, finally adopted by the Chemin de Fer de l'Etat as their standard express engine, of which over sixty have since been built by the various well-known Belgian firms, including the St. Leonard Company. At that date the old "Type 1," with four coupled drivers, single leaders, Belpaire fire-box, and large dome placed directly behind the chimney, was proving insufficient for the increasing weight of the trains, particularly with the heavy international cars and the spacious ordinary six-wheeled carriages—trains which compared rather with German than with French rolling stock as regards both weight and accommodation.

In calling for competitive designs of new engines, the authorities required that the competing locomotives should be able to haul a gross load of 150 tons up a gradient of 1 in 200 at 56 miles per hour, without diminution of steam pressure or of the level of the water in the boiler, for a distance of three miles at least. Both engines referred to above proved very satisfactory, and attained speeds of 59 miles per hour under the conditions named. Indeed, the triple-boiler engine ran up the grade stated at 61 miles per hour, and took trains of 150 tons gross (that is, including engines) up inclines of 1 in 62 at 40 miles per hour, and, on other occasions, loads of 182 tons up the same gradient at 31 miles per hour. From these results, obtained under similar conditions, the powers developed by the two engines were found to be 1,235 H P. for the triple-boiler locomotive, and 1,169 H.P. by the "Type 12." At 59.4 miles per hour, with 150 tons, on a grade of 1 in 200, the power of the triple-boiler engine exerted 1,339 H.P.

The two engines in question differed mainly in their boilers, as they had the same cylinder capacities. As will be seen from our engravings, the engine illustrated has a boiler with three barrels, which have the same fire-box tube-plate, and the same extension smoke-box in common. The chimney is square, spreading out at its base to embrace the side divisions of the smoke-box, an arrangement which should improve the draught in the side flues, although it may be doubted if the exhaust steam acts so efficiently in a square chimney as in a round one, and it is certain that it obstructs the view somewhat. The



TRIPLE BOILER LOCOMOTIVE FOR THE BELGIAN STATE RAILWAY.

smoke and steam also are said to be thrown less clear away from the engine than with the round forms. The grate area is double that of any French express engines and superior to that of "Type 12," and the heating surface is 50 per cent. more than in the "Type 12" and 10 square meters (107 sq. ft.) above that obtained in Flaman's double-boiler locomotive.

The coal consumption is given as 254 to 322 kilogrammes per hour per square meter of grate surface; in other words, it burns an average of 3,167 lbs. per hour, which, taking the commercial speed as 44 miles per hour, corresponds to 72 lbs. per mile; 1 lb. of coal is said to evaporate 5.6 lbs. of water upon the average, or 6.6 lbs. as a maximum, results no better than obtained with American locomotives; but the coal burned by these Belgian locomotives is of the poorest "slack," unmixed with briquettes, as commonly practiced in France. As regards economy, the results given by the engine are said to be excellent. There are, it is true, certain details of construction that could be improved even in the existing engine, as, for example, the square chimney and the absence of running-boards permitting the engine to be got at when under way. There is also sometimes an unequal expansion of the tube-plate, due to a superior draft in the central series of tubes. A trouble also with engines of abnormally large grate area is the difficulty of obtaining a sufficient draft in the smoke-box. The locomotive in question is one of the most unconventional developments of locomotive practice since the time of Stephenson. It was designed with a view of obtaining great steaming power without mounting the boiler dangerously high. Continental and American trains make greater demands on the steam-producing capacity of the boilers than is the case in England, hence these multiple boilers of Flaman, the St. Leonard's Company, and others have been produced.

The principal dimensions of the engine are as follows:

Fire-box, width inside	9′ 8″
" " outside	9′ 10″
" length inside	5′ 10″
" " outside	6′ 8″
" height, front	3′ 7″
" " back	2′ 9″
Grate area	56 sq. ft.
Boiler, central	4′ 3″ in diam.
Boilers, side	2′ 3″ "
Tubes, central	180
" side series (48 each)	96
Total	276
Tubes, length	15′
Working pressure	180 lbs. per sq. in.
Heating surface, fire-box	121.6 sq. ft.
" " boilers	1931.0 "
Total	2052.6 sq. ft.
Cylinders, diameter	19.6″
Stroke	23.5″
Drivers	6′ 10½″ in diam.
Weight, engine	56.8 tons.
" tender	29.5 "
Total	86.3 tons.

—*Engineering.*

THE YARROW BOILER.

Apropos of the discussion before the meeting of the Mechanical Engineers, which is printed in another column, we would call attention to the Yarrow boiler, a description of which was published in our issue for March, 1891, and which is now being exploited in this country by Mr. Horace See, of No. 1 Broadway, New York. Inasmuch as the engravings published in our former issue gave a complete description of the construction of the boiler, it is not necessary to recapitulate the whole at the present time. It consists of three parallel longitudinal chambers, two of which are of the form of the sector of a circle, while the third and upper is a complete circle. The three chambers are located at the angles of a nearly equilateral triangle with the grate between the lower two, while straight tubes connect the lower and the upper ones. The engraving which we publish in this connection is taken from a photograph of a boiler which has recently been built by Mr. Yarrow in England. Boilers of this type were used on the torpedo boat *Hornet*, a description of whose trial appears in another column of this issue.

In a recent discussion before the Institution of Naval Architects in England, Mr. Yarrow stated that it was about seven years ago that his firm first commenced adopting straight tubes in their water-tube boilers, having been previously led away by what he believed to be the popular fallacy that curved tubes were necessary in order to allow for contraction and expansion. No doubt it was necessary to curve the tubes in some designs, but it did not follow that it was necessary in all.

Although his firm had built a large number of water-tube boilers during the last seven years with straight tubes, it might be of interest to the meeting to know that they had never had a single leakage between the tube and tube-plate. This fact proved, they believed, that there was nothing objectionable in the straight tube system, while it clearly offered many advantages, both in construction and in service. Experience had shown that steel tubes, whether galvanized or not, rapidly deteriorated, and if the tubes were galvanized on the inside a rough surface was caused, which, in some instances, retarded the circulation of the water. There was also the possibility of portions of spelter lodging in the tubes and partially blocking up the passage, or causing such an obstruction which would allow sediment to collect. So far as his experience went, it led to the conclusion that copper tubes were more durable than steel, but in the use of copper it was essential that it should be very pure, and that the tube, under all circumstances, should be below the level of the water and always filled, otherwise the copper might become overheated.

He also stated that his firm commenced experiments with water-tube boilers as far back as 1877, and put a water-tube boiler in a torpedo boat in the year 1889, and their experience indicated that very small changes in design materially affect the action of a boiler; small alterations in some cases making the difference between success and failure. If portions of the boiler be rigidly secured by stays, which are not subject to the same temperature as the tubes, serious strains may be set up involving continual bending of the tubes to meet continual variations of temperature. If in such cases the tubes be only slightly bent, it might lead to trouble, as small alterations in length involve considerable alterations in the curve necessary to conform to the variation in length. Consequently in cases where portions of the boiler are rigidly secured to one another, it is necessary that the bends in the tubes should be considerable, so that they can easily, and without excessive strain, suit differences of temperature. The practice of his firm was to aim at allowing tubes freedom to expand and contract; and, as the contraction and expansion of a group of tubes had been found to be nearly uniform under the conditions of working, any small difference of length seemed to be met by the elasticity of the material. Mr. Yarrow, and those who worked with him, felt satisfied on this point, having made very careful experiments to test it, and he thought it would be admitted that it was most desirable—in fact, almost essential—that access be freely obtained to the interior of the tubes, for the purpose of examination and for cleaning. For these reasons he was strongly in favor of straight tubes, which at the same time reduced the cost of construction, and was a convenience in actual working on account of the ease in supplying spare tubes. In this way there was avoided the large variety of forms of spare tubes necessary with boilers where the tubes were curved to different forms.

It was often asked, Mr. Yarrow continued, how, in boilers such as those in H. M. S. *Hornet* and other previous vessels, they managed to replace the tubes. The form of boilers adopted in the *Hornet*, to which the speaker was referring, was not of the type described in Mr. Milton's paper just read, and, as throwing some light on the subject, it might interest the meeting to know that on one of the trials with this vessel (in the boilers of which there are over 8,000 tubes) one of the tubes gave way on account of faulty manufacture, and the time occupied in taking out and replacing this tube ready for expanding was only 40 minutes. His firm were also led away in their first boilers with the idea that down pipes were necessary to insure circulation, and in all the boilers made by them up to three years ago they provided four down pipes, two at each end; these down pipes being suitably curved to allow for variations in lengths between the upper and lower portions of the boiler. For purposes of experiment they removed two of the down pipes, and found the action of the boiler unaffected. They then ultimately dispensed with the other two, with the same result, thereby saving both weight and length and obtaining greater simplicity. Mr. Yarrow maintained that those who had had both water-tube boilers of a satisfactory type under their management, and those of the locomotive type, would be ready to admit that it required less skill to stoke a water-tube boiler than a locomotive boiler, as with the latter it was necessary to keep the grate uniformly covered with fuel for fear of admitting cold air, while with the former such care was unnecessary. In order to test the effect of sudden changes of temperature on one of his firm's water-tube boilers, they had, when experimenting with it in the yard, forced it excessively, and had then suddenly pulled out the fire and stripped the boiler of its casings, so as to cool it as quickly as possible. They then replaced the casings, lit up as rapidly as possible, raising steam to 180 lbs. The result of this somewhat severe treatment showed that there was not the

slightest alteration in form or any injury to the boiler. The results obtained with one of the boilers of H. M. S. *Hornet*, Mr. Yarrow thought, would, perhaps, interest the meeting. It weighed complete, with fittings, smoke-box, fire-doors, fire-bricks, funnel, casings, and all boiler mountings, also including water up to working level, 5 tons 7 cwt. On carefully conducted experiments in the yard it was found that 12,500 lbs. of water were evaporated per hour from 60° F. to 180 lbs. pressure. In order to compare the relative efficiency of water-tube boilers with locomotive boilers, there were the following facts: In H. M. S. *Havock* his firm had placed two locomotive boilers, and the machinery indicated on trial about 3,500 H.P., with an air pressure of 3 in. In the *Hornet*, a sister ship, provided with similar engines and fitted with eight water-tube boilers, as previously mentioned, they obtained, with a very low air pressure averaging 1½ in., 4,300 H P. The eight boilers in the *Hornet* weighed 11 tons less than the locomotive boilers in the *Havock*.

They had every reason to fear, from what they had been told, that trouble would be experienced in working a group of small rapidly evaporating boilers in the *Hornet*, but, as a matter of fact, they had experienced no difficulty whatever, the feed being arranged in, as it were, two stages. The feed-pumps on the engines take their suction from the hot-well, and deliver into a reservoir at 50 lbs. pressure, and from this reservoir the donkeys take their suction, each boiler being provided with an independent donkey. By this means a very ample supply of water was always insured on the suction side of the donkeys, and the pipes leading to them could be of moderate dimensions, in consequence of the 50 lbs. pressure delivering the water readily to the suction side of the pumps. To insure the reservoir always being well filled, there was a small amount of auxiliary feed constantly passing into it, the surplus, beyond that which was necessary for the supply of the boilers, being returned to the tank through a relief valve loaded to 50 lbs. As was well known, his firm had been strong advocates for the locomotive type of boiler, especially as the form they had adopted was found to work satisfactorily and to be durable; but the recent success with water-tube boilers obliged them to advance with the times and to modify their opinion, a course more particularly necessary in view of the possible further rise of working pressures in the immediate future. The recent action of the Admiralty in, as it was, forcing on numerous contractors the adoption of water-tube boilers had frequently been unfavorably criticised, but Mr. Yarrow believed that time would prove that the greatest possible credit was due to the authorities for having thus taken the initiative in the introduction in this country of a form of boiler which there was little doubt is destined to replace old types. He was fully convinced that, in spite of those failures which were naturally to be expected to accompany such a sudden change of practice, naval architects and engineers would, in a few years, recognize in the action of the British Admiralty a wise and important step in the advance of marine engineering, and he believed before very long that it would be generally admitted, not only in this country, but throughout the world, that the greatest credit was due to the authorities at Whitehall for having had the boldness to act as they had done.

THE YARROW BOILER.

LOCOMOTIVE VALVE-GEAR WITH SEPARATE ADMISSION AND EXHAUST-VALVES.

By E. Polonceau.

The Paris & Orleans Railway Company have from time to time tried to get more economical results from their locomotives than is possible when using the ordinary slide-valve for both admission and exhaust. In 1856 a Meyer expansion valve-gear was tried, but the results were not satisfactory; the increased economy obtained being more than counterbalanced by the extra friction of the valves and the extra complication of the mechanism. In 1878 a compound locomotive was tried, but again the results were unsatisfactory. It is to be remarked that compounding involves a more or less complete transformation of the locomotive, and that consequently on account of expense it cannot be applied to all the engines already existing. It appears, therefore, to be simpler to try to get increased economy by a change which will only involve replacing the cylinders and part of the valve-gear. These considerations led the Company to try the system described below, recommended by Messrs. Durant and Lencauchez.

The immediate aim of the experiments was to prolong the expansion and to suitably control the compression while still using a link-motion gear. In the first trial made, on engine No. 67, the admission slide-valve was driven by a Gooch link-motion, and had certain peculiarities of construction, the object being to double the area of opening and to partially relieve the pressure on the face. The exhaust slide-valve, placed at the lower side of the cylinder, received its motion from the cross-head. Exhaust began when the piston had still 22 per cent. of its stroke to perform, and compression began when it had done 22 per cent. of the return stroke. At low speeds the results were satisfactory, but at high speeds the great amount of compression was objectionable.

In the second trial another locomotive, No. 76, had two exhaust-valves of the Corliss type driven from the cross-head, and the cylinders were larger. Here, again, the compression was too great for high speeds.

In the next arrangement tried the rods driving the admission and exhaust-valves worked in the same link, and were connected to each other, so that they were displaced simultaneously; the same engines on which the above experiments were made being used, cylinders and valves being unaltered. In engine No. 67 release took place when 25 per cent. of the piston-stroke remained to be done, and compression began

when 30 per cent. of the return stroke had been done. The results were entirely satisfactory, reversing being easily performed, and a greater amount of work for the same weight of steam being obtained than with ordinary locomotives.

As a result of the preceding experiments, new cylinders with four Corliss valves and the smallest possible clearance spaces were fitted to engine No. 67, and this design has been applied to all new passenger engines for the last year and a half. The advantages of this arrangement are as follows :

1. The conditions relating to cooling of the steam on entering the cylinder are better than in the ordinary engines, since the sides of the admission-ports are not cooled by the escape of the exhaust steam.

2. The fall of pressure is less, since the port area is nearly double.

3. The diminution of the clearance volume, prolongation of the expansion, lessening of the compression are all favorable to the more efficient use of the steam in the cylinder.

4. The back pressure is lessened by the diminution of the clearance volume, since the quantity of exhaust steam to be got rid of is reduced.

5. The friction of the four Corliss valves is less than that of an ordinary slide-valve.

6. The arrangement of the exhaust-valves at the lower side of the cylinder allows a natural drainage to take place, and drain-cocks are therefore unnecessary.

The design has been applied to eight express engines, and is being applied to three express and three goods engines in course of construction. One of these engines coming into the shops for overhaul after running 40 200 miles, the valves and valve-gear were examined. The wear of the valves and the joints of the link-motion was practically *nil*. With ordinary locomotives the valves and faces usually require adjustment after running about 15,000 miles. The consumption of fuel is 15.2 per cent. less than the average in the ordinary engines doing the same work. The expenditure of lubricant is a little higher, being 51 as against 42 grams per kilometer. —*Annales des Mines.*

ACADEMY AND HOME FOR SHIPBUILDERS.

On Saturday, May 5, the new building which has just been completed through the munificence of Mr. William H. Webb, the distinguished shipbuilder, was dedicated to the uses for which it is intended. These are indicated by its name, which is "Webb's Academy and Home." Its purpose is to establish a sort of refuge or home for poor men who have worked on the hulls or engines of ships ; and, second, a school of naval construction for boys who are unable to secure the advantages of such an education elsewhere. Mr. Webb has devoted $2,000,000 to establishing this home and school.

The building is located at Fordham Heights, facing on Sedgewick Avenue, overlooking the Hudson and Harlem rivers. Thirteen acres of ground were bought for this purpose, and the magnificent building is a striking feature in this picturesque region. As will be seen from the illustration—for which we are indebted to *Seaboard*—the main structure is of the Romanesque order of architecture, of plain stone, and round arches on the upper tier of windows. It provides the most complete facilities for the purpose for which it is intended that the broadest liberality could supply. Not only is it intended that it shall be a home for poor men, but it is intended that when misfortune has overtaken men whose wives are dependent upon them, that they shall not be separated, and that they may descend the decline of life, hand in hand, if they are disposed to do so. With this in view, provision has been made so that poor men and their wives will both be cared for. The school, it is said, will be on a par with the leading educational institutions of the world for teaching the most advanced methods of marine construction.

The dedicatory exercises were led by Bishop Henry C. Potter, of the New York Diocese.

The institution has been incorporated, and the trustees are W. H. Webb, President ; Stevenson Taylor, Secretary ; Thomas F. Rowland, Treasurer ; Professor Frederick R. Hutton, Columbia College ; Andrew Reed, Resident Trustee ; Albert G Bogert, Charles S. Smith, Merritt Trimble, T. S. Marvel, Newburgh, and Charles H. Cramp, Philadelphia.

It is magnificent benefactions like this which renew one's hope in the future of our people, which is now often sorely shaken by the ignorance, imbecility, and corruption in high places.

WEBB'S ACADEMY AND HOME FOR SHIPBUILDERS.

BRIDGE ON DULUTH, MISSABE & NORTHERN RAILWAY.

The building of the Duluth, Missabe & Northern Railway, from the junction with the Duluth & Winnipeg Railroad into Duluth, Minn., necessitated the construction of extensive dock facilities on St. Louis Bay. To reach the dock a viaduct about 2,500 ft. long and double track was constructed across the flats. The work was laid out by Mr. C. H. Martz, Chief Engineer for the Railroad Company, and the contract awarded to the Youngstown Bridge Company, of Youngstown, O., for the construction of the viaduct, according to their own designs, to be built of soft steel not reamed. The crossing of the streets necessitated the use of six or eight spans without longitudinal bracing. These spans, together with the one across the St. Paul & Duluth Railroad tracks, varied from 44 ft. to 86 ft. in length. The one which we illustrate is the span across the tracks of the St. Paul & Duluth Railroad. The extreme length is 86 ft., with a skew of 61° 30'. The span is double track, through on shelf. The live load used consisted of two 101-ton consolidation locomotives. The center girder weighed when completed 33 tons, and, as was true of

all the work in this structure, the flange angles and flange plates were all in one piece without splice. The bracing between the girders consisted of adjustable lateral rods and deep lattice struts, with gussets running to the top flange of the girders, each gusset being stiffened on the edge by two angles. The girders rest on steel columns, which are braced to the girders by knee braces, as shown in the cut. The columns are calculated to take up the bending strains due to traction and temperature. The transverse sway bracing was of adjustable rods, owing to the fact that the foundations rest on piling, thus precluding the possibility of using stiff sway bracing, as a number of structures that have been built with stiff bracing, when the foundations were on piles, have been found, in other parts of the country, to settle and render the stiff sway bracing of little service. Any slight settlement in the foundations can be accounted for by the adjustable laterals. The other spans in the viaduct were built of the same general design as this, except they were all deck, with stiff lateral bracing and frames. Besides the viaduct proper, the Youngstown Bridge Company constructed for the road two girder spans in the dock proper, and a 72-ft. girder span on columns on the line of the road. The Duluth, Missabe & Northern Railway, by means of this improvement, are enabled to haul the ore from the renowned Missabe Range to St. Louis Bay over their own tracks the entire distance, and have facilities for handling ore second to no road in the United States.

BRIDGE ON DULUTH, MISSABE & NORTHERN RAILWAY, BUILT BY THE YOUNGSTOWN BRIDGE COMPANY.

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

THE object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publication will in time indicate some of the causes of accidents of this kind, and help to lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with information which will help to make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we all intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in April, has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS IN APRIL.

Pittsburgh, Pa., April 5.—F. J. Suter, a fireman on the Pennsylvania Railroad, was killed yesterday afternoon in the Twenty-eighth Street yards while working with the air-brakes

LOCOMOTIVE RETURNS FOR THE MONTH OF FEBRUARY, 1894.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage.					Av. Train.		Coal Burned per Mile.						Cost per Locomotive Mile.							Cost per Car Mile.		Cost of Coal per Ton.
			Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Passenger Cars.	Freight Cars.	Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Passenger.	Freight.	
										Lbs.	Lbs.	Lbs.	[illegible]	Lbs.	Lbs.	Cts.	Cts.	Cts.	[illegible]	Cts.	Cts.	Cts.	Cts.	Cts.	$
Atchison, Topeka & Santa Fé	[illegible]																								
Canadian Pacific	[illegible]		448,166	586,076	266,709	1,295,955	2,152						89.51			5.15	12.69	0.37		5.88	1.46	25.49			3.07
Chic., Burlington & Quincy	[illegible]					1,305,091	2,409	4.78	18.40				92.66			4.15	6.51	0.20	0.34	5.81	0.06	16.07			1.40
Chic., Milwaukee & St. Paul	[illegible]					2,265,455	2,770						80.74			4.14	8.24	0.28		6.69		19.55			2.48
Chic., Rock Island & Pacific	564		489,842	799,710	360,563	1,580,115	2,712			61.70	85.48	40.96	71.71			8.18	7.29	0.35		6.98	0.42	17.42			2.18
Chicago & Northwestern	1010		794,255	1,347,306	519,159	2,490,700	2,466						96.66			3.72	6.64	0.30		6.29	0.89	20.04			1.81
Cincinnati Southern																									
Cumberland & Penn.*	38	38	5,458	21,237		26,695	1,147						88.66			9.69	4.41	0.31			2.33	16.74			
Delaware, Lackawanna & W. Main L.	212	171	65,825	182,940	376,589	585,354	3,078						96.90			2.53	7.31	0.42		6.35		16.61			1.60
Morris & Essex Division	169		164,796	136,780	76,248	379,830	3,044						71.02			8.11	11.06	0.33		7.06		21.57			3.09
Hannibal & St. Joseph	65	65	59,613	137,318	34,961	231,892	3,567	4.66	16.21				90.90	16.16	7.34	9.61	6.14	0.10	0.33	6.76	0.06	16.17			1.89
Kansas City, Ft. S. & Memphis	146		88,440	197,501	87,475	370,416	2,509						77.22			2.96	5.83	0.19	0.45	7.39		16.79			1.49
Kan. City, Mem. & Birm	41	36	33,694	59,511	11,349	96,754	2,546						78.53			3.84	4.09	0.26	0.53	6.99		15.51			1.07
Kan. City, St. Jo. & Council Bluffs	37	37				128,794	3,346	5.04	18.74				76.61	16.40	5.37	3.75	7.61	0.17	0.94	6.79	0.06	19.81			1.96
Lake Shore & Mich. Southern	593		380,306	746,603	370,316	1,498,121	2,796			67.78	98.91	41.96	75.82			3.96	5.70	0.05	0.12	6.89	0.19	15.94			1.56
Louisville & Nashville																									
Manhattan Elevated		302	700,882		62,300	763,182	2,501						48.19			2.40	9.60	0.30		9.00		21.30			3.99
Mexican Central																									
Minn., St. Paul & Sault Ste. Marie	104	74	76,471	116,172	22,712	215,355	2,910	4.49	19.16				32.66		6.15	5.85	14.87	0.96		6.55		27.53	5.30	1.76	3.57
Missouri Pacific	351					647,196	2,973	4.39	16.67				99.15			4.50	6.68	0.84	1.44	5.49	1.61	21.96	3.76	1.56	1.36
Mobile & Ohio	107	88	68,642	139,380	50,129	258,151	3,109						70.49			3.31	5.05	0.20	0.66	6.38	0.98	15.40			1.46
N. O. and Northeastern																									
N. Y., Lake Erie & Western	632	411	390,519	689,715	211,671	1,291,905	2,997	4.90	21.40	96.50	146.00	109.25	117.96	22.50	6.80	5.66	8.33	0.39	2.46	7.42	1.35	25.88			1.41
N. Y., N. H. & H., Old Colony Div.			363,370	141,378	170,164	675,965		3.70	15.10				69.80	19.50	6.40	3.49	10.47	0.66		7.37	0.83	23.72			
N. Y., Pennsylvania & Ohio	279	176	113,559	296,136	104,989	514,707	2,924	5.10	18.20	85.60	151.10	99.05	111.88	16.60	6.30	4.80	6.58	0.32	2.96	7.05	1.32	23.36			1.06
Norfolk & Western, Gen. East. Div.†			84,440	215,265	42,860	342,565	3,239	4.78	20.97	49.98	128.06		90.99	10.38	6.20	5.41	3.38	0.30				9.59			3.50
General Western Division†			90,689	256,498	44,898	394,015	2,461	5.46	17.78	84.00	187.00		197.00	15.34	5.68	5.21	4.46	0.28				9.95			
Ohio and Mississippi																									
Philadelphia & Reading			884,485	956,996	697,112	1,888,545							86.31			4.05	4.97	0.35		5.77	0.48	15.63			
Southern Pacific, Pacific System	726	632	581,826	577,577	244,338	1,403,581	2,221	5.38	13.06				66.64			6.19	16.00	0.31	2.39	7.36	1.30	33.36			4.80
Union Pacific																									
Wabash	418	327	391,144	533,688	190,649	1,115,481	3,411	4.43	15.60	68.70	116.00	66.62	93.28	16.62	7.33	3.28	5.31	0.28		6.13	0.97	15.77	3.08	1.16	1.15
Wisconsin Central	149	97	106,080	139,485	43,118	286,683	2,975						86.06			2.99	9.80	0.16		7.86		20.21			2.25

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars. Empty cars which are reckoned as one loaded car are not given upon all of the official reports, from which the above table is compiled. The Union and Southern Pacific, and New York, New Haven & Hartford rate two empties as one loaded; the Kansas City, St. Joseph & Council Bluffs and Hannibal & St. Joseph Railroads rate three empties as two loaded; and the Missouri Pacific and the Wabash Railroads rate five empties as three loaded, so the average may be taken as practically two empties to one loaded.

* Switching engines allowed 6 miles per hour; wood, construction and gravel trains, 10 miles per hour.

† Wages of engineers and firemen not included in cost.

under his engine. A brake lever was suddenly thrown out against his head, killing him instantly.

Clarksville, Tenn., April 5.—While a freight train on the C. & O. Railroad was passing Cumberland City Station this evening, some one threw a stone into the cab, striking the fireman over the eye, inflicting quite a severe injury.

Batavia, N. Y., April 5.—A tire on an engine of the Lehigh Valley Railroad broke while the engine was running at the rate of 35 miles an hour near here this afternoon. The fireman and engineer were slightly injured.

Rouse's Point, N. Y., April 5.—A misplaced switch caused the derailment of a train on the Delaware & Hudson Canal Company's Railroad at this point this morning. A man in front of the switch lights prevented the engineer from seeing the open switch. The engineer and fireman escaped with slight injuries.

Lake Benton, Minn., April 6.—A regular west-bound passenger train on the Winona & St. Peter branch of the Chicago & Northwestern Railroad, jumped the track half a mile east of here to-day. Engineer Ed. Frary was instantly crushed to death under the engine.

Cairo, Ill., April 6.—Engineer Charles H. Norris, of the Illinois Central Road, had his legs so badly crushed that they had to be amputated, as the result of a collision between his engine and some cars at this point this evening. The shock of the collision threw the throttle wide open and the engine ran down the track.

Dalleston, Pa., April 7.—A gas explosion in the fire-box of the Philadelphia & Reading Railroad engine, causing the flames to shoot out at the door, burned Isaac Van Pelt, fireman of the engine, about the head and face very badly this afternoon.

New Era, Mich., April 9.—An engine on a logging railroad belonging to Staples & Covel ran into a tree and was knocked over a 16-ft. embankment, carrying nine men with it. Among the killed were Adolph Shelander, engineer, and Gus Anderson, fireman.

Port Chester, N. Y., April 12.—An express train on the New York, New Haven & Hartford Railroad ran into a caboose at this point to-day. James Gaffney, fireman of the express train, was severely hurt about the arms, body, and face.

Lancaster, Pa., April 13.—An engine on the Pennsylvania Railroad, while running backward and hauling a caboose, was derailed at this point to-day. The wheels of the pony truck left the rails, pierced the caboose, and cut it into fragments. Fireman I. C. Cover had his hip injured by leaping from the engine.

Pottsville, Pa., April 13.—There was a collision at Morris Junction of the Philadelphia & Erie Division of the Pennsylvania Railroad, between a Lehigh Valley passenger train and the Pennsylvania train of empty cars. The engineer of the passenger train was thrown off his engine and badly bruised.

Hilliard, Wyo. Ter., April 14.—A train on the Union Pacific Railroad was ditched half a mile east of here to-night. H. George, fireman, and William Lethbridge, the engineer, were instantly killed.

Hazleton, Pa., April 15.—There was a collision between a Pennsylvania freight and a Lehigh Valley express train at Silver Brook at noon to-day. Engineer Kimmel, of the freight train, had his eye cut and back and head bruised. Fireman Art Brown had one leg broken and was otherwise injured.

Salt Lake City, April 17.—A landslide occurred at Weaver Cañon, on the Union Pacific Railroad, to-day, causing an accident to a freight train. The fireman of the engine had one leg broken.

Reading, Pa., April 18.—Philip M. Lehr, a fireman on a passenger train of the Pennsylvania Railroad, was leaning out of his cab north of here, and was caught by a signal post and dragged from the engine. His skull was crushed.

Goshen, Ind., April 19.—An express train on the Lake Shore & Michigan Southern Railroad ran into the caboose of a freight train standing on the track that did not clear the main track, at Dunlap to-day. Engineer Charles Melcher remained at his post and was very severely injured. Fireman Nopper jumped and sustained severe injuries by being thrown against the fence.

Watertown, N. Y., April 19.—While a train on the Rome, Watertown & Ogdensburg Railroad was standing on the Y at Theresa Junction, waiting for another train to pass, the latter came down and ran through an open switch at the rate of 30 miles an hour, crushing into the engine of the waiting train. The engine of the latter was driven back against the tender, catching the engineer as it went and killing him. The fireman jumped and broke his leg.

Calais, Me., April 19.—The locomotive and tender of a train on the Shore Line Railroad left the rails near here this morning. The engineer was severely injured. The accident was caused by the spreading of the rails.

Denver, Col., April 19.—A passenger train on the Burlington & Missouri Railroad was ditched to-day by a sand drift on the track near Yuma, Col. Engineer Pat Quinlan and Fireman Bert Goodwin were seriously hurt.

Carlisle, Pa., April 20.—A passenger train on the Cumberland Valley Railroad struck an empty box car that had been blown by the wind from a siding on to the main track, about 3 miles south of here to-night. The engine fell over on its side, and both engineer and fireman were jammed between the engine and tender, but escaped serious injury.

Hartford City, Ind., April 21.—A Pan Handle freight train plunged down an embankment near here to-day. J. A. Phillips, the engineer, was fatally injured, and C. L. Tucker, the fireman, had both legs broken. The accident was caused by the engineer running into an open switch, believing he was on the main track.

Lancaster, N. H., April 22.—A freight train on the Grand Trunk Railway ran into a washout at a bridge over the Nulhegan River, near Wenlock, to-night. The engineer was killed and the fireman badly injured.

Sherman, Tex., April 26.—A freight train on the Houston & Texas Central Railroad was wrecked 1 mile north of Van Alstyne this morning. Circumstances indicate a premeditated case of train-wrecking. A cross-tie placed near the cattle guard was the obstruction. Charlie Clappert, the engineer, was slightly scratched.

Patchogue, L. I., April 26.—Eugene Bancroft, an engineer on the Long Island Railroad, was stepping from his engine this morning when he slipped and fell between the driving-wheels. Both legs were crushed, the right one being entirely severed at the hip.

Winnipeg, Manitoba, April 27.—A broken rail caused an engine and three cars to leave the track of the Canadian Pacific Railroad near here to-day. The engineer was seriously hurt.

Houston, Tex., April 28.—On the Atchison, Topeka & Santa Fé Railroad, between Kenny and Bellville, a rock train ran into the rear of a freight, telescoping the freight and several of the cars. Dad Christian, the engineer of the rock train, was badly hurt.

St. Louis, Mo., April 30.—Two switch engines with heavy trains behind them collided in the yards of the St. Louis, Keokuk & Northwestern Railway to-night. C. Berkshaw, a fireman, was scalded to death.

Jacksonville, Fla., April 30.—A train on the Florida Central & Peninsula Railroad jumped the track and went through a 30-ft. trestle near Plant City, Fla. The locomotive turned a complete somersault, and the engineer went down under it. His legs were crushed and his head and shoulders badly scalded.

Our report for April, it will be seen, includes 28 accidents, in which 5 engineers and 5 firemen were killed, and 15 engineers and 14 firemen were injured. The causes of the accidents may be classified as follows:

Broken rail	1
Broken tire	1
Collisions	8
Defective air-brake	1
Derailments	6
Falling from engine	1
Gas explosion	1
Landslide	2
Misplaced switch	2
Obstruction on track	1
Stone-throwing	1
Struck by obstruction	1
Train-wreckers	1
Washout	1
Total	28

PROCEEDINGS OF SOCIETIES.

American Society of Mechanical Engineers.—The announcement has been sent out that the spring meeting of this Society will be held at Montreal, Canada, from June 5 to June 9. The opening session will be held at Molson Hall, at McGill University, at 8.30 P.M. of Tuesday. The following papers will be read and discussed: A. K. Mansfield, Notes on the Theory of Shaft Governors; Albert F. Hall, Heat Units and the Specifications for Pumping Engines; W. H. Bristol, A New Recording Pressure Gauge for Extremely High Ranges of Pressure; Frank Richards, A Note on Compressed Air; A. W.

Robinson. The Relation of the Drawing Office to the Shop in Manufacturing; R. H. Thurston, The Theory of the Steam Jacket; Current Practice; D. S. Jacobus, Results of Experiments with a 50-H.P. Single Non condensing Ball & Wood Engine to Determine the Influence of Compression on Water Consumption; Frank H. Ball, Cylinder Proportions for Compound Engines, Determined by their Free Expansion Losses; F. M. Rites, A New Method of Compound Steam Distribution; Jesse M. Smith, Tests of a Small Electric Railway Plant; W. S. Aldrich, Power Losses in the Transmissive Machinery of Central Stations; M. P. Wood, Rustless Coatings for Iron and Steel; James McBride, Corrosion of Steam Drums; C. W. Hunt, A New Mechanical Fluid; F. R. Hutton, First Stationary Steam Engines in America; DeCourcy May, Cost of an Indicated H.P.; John R. Freeman, A New Form of Canal Waste Weir; G. W. Bissell, Effect of Varying the Weight of the Regenerator in a Hot-air Engine; W. R. Roney, Mechanical Draft for Boilers; R. C. Carpenter, The Saturation Curve as a Reference Line for Indicator Diagrams; Denton-Jacobus-Rice, Results of Measurement of the Water Consumption of an Unjacketed 1,600 H.P. Compound Harris-Corliss Engine; F. B. King, Notes on the Corrosion of a Cast-steel Propeller Blade.

The social entertainments will consist of an informal drive about Mont Royal Park, an excursion by special train to Lachine and down the rapids, an excursion to the dredging operations conducted in the harbor, visits to the Montreal Street Railway Company's power house, with luncheon and inspection of the power plant, a garden party at the house of Mrs. J. H. R. Molson, and an excursion to Ottawa by special train over the Canadian Pacific Railroad. Notice has been sent out by the Secretary that an effort is being made to secure the facilities of a special train by way of the Vermont Central Railroad, so that passengers from New York City, meeting the New England contingent in cars from Boston at White River Junction, can enjoy the pleasures of a journey at no greater cost than the regular rate, and perhaps at a reduction of fare. The train will probably leave New York at ten o'clock Monday morning, June 4. The headquarters are to be at the Windsor Hotel, where the rates are from $3 to $3.50 per day. Members are specially requested to wear the button badge used at conventions, as they render social acquaintance more easy.

Engineers' Society of Western Pennsylvania.—At the regular meeting of March 20, Mr. Thomas B. Nichols read a paper describing the emerald mines of Muzo, in the Republic of Colombia, South America. These mines have been worked for upward of two hundred years, and were known long before the Spaniards explored and took possession of the country, and they are still said to be the richest emerald mines in the world. The entrance to the mines is at the end of a ridge, near the junction of two mountain streams. The rock is bituminous black limestone, for the most part laminated like slate, the slabs being 2 or 3 in. thick. These are separated from each other by layers of a black powder. This formation is thickly crossed by innumerable veins of carbonate of lime, in the intersections of which veins the emeralds, in a rough state, are found, generally associated with crystals of a transparent quartz and a yellow mineral not yet classified. The finest stones are found in the black powder. The mine itself is in a deep basin excavated back of a sharp ridge, and is about 600 ft. in diameter and 100 ft. deep. The water from the mine is drained from it through a trough about 150 ft. to an adjoining brook. In the rainy season this brook becomes a furious torrent.

In the center of the mine, a little to the left, is placed a small shed, where the superintendent can watch the operations of the miners. The only tool these miners use is an iron crowbar ¾ in. thick, with a chisel edge, and weighing 25 lbs. With this instrument the rock is broken and allowed to fall into a sluiceway beneath. Water is collected in a tank above. When the quantity is sufficient, it is let fall on the mass below, and by this means the débris is washed away, leaving the emeralds in the sluices. Every evening the sluices are carefully examined and the emeralds collected. Even the close watching of the superintendent, however, fails to get all the emeralds for the mine owners, for a great many of the stones are stolen by the miners, who, as a general rule, are not very honest. A former manager of the mines, with whom I was acquainted, told me that perhaps 25 per cent. of the gems never went into the hands of the company, but were taken by workmen and sold on their own account. The demand for the stones influences the number of workmen employed This number varies at times from 50 to 500. They are fed by the company, and it costs 20 cents a day to feed each man. Their wages vary from 20 to 40 cents a day.

The mines are owned by the Colombian Government, but are operated by an English company, which rents them from the owners. The mines are two in number. Before the fall of Napoleon III. the Empress Eugenie was said to possess the largest emerald in the world.

Association of Engineers of the South.—At a recent meeting Mr. Samuel Wallace gave a talk on paints, bringing out considerable valuable and interesting information. Among other things he gave a description of the best method of painting ironwork, in which he recommended that the first coat should consist of pure red lead in powder and raw oil to be used within two or three weeks after mixing, and to be kept thoroughly mixed while using. This will dry in from 24 to 30 hours. The red lead should be ground in a mill, if possible, immediately before using. If the finish is to be black, use two coats made from paste consisting of 65 per cent. pigment and 35 per cent. raw oil. The pigment to consist of 65 per cent. sulphate of lime, 30 per cent. lampblack, and 5 per cent. red lead as a dryer. The whole thinned to a proper consistency with pure boiled oil. This paint ready for use will cost about 65 cents per gallon. If the finish is to be in red or brown, use a paste consisting of 75 per cent. pigment and 25 per cent. pure raw oil. The pigment to consist of 55 per cent. sulphate of lime, 40 per cent. oxide of iron free from sulphur and caustic substances, and 5 per cent. carbonate of lime as a dryer. The sulphate of lime to be fully hydrated. This paint will cost, ready for use, about 60 cents per gallon. Lead paints are not recommended for finishing coats on account of chalking, neither is zinc on account of cracking. Graphite paint does not dry well in linseed oil, and is not impervious to water. The color is steel gray. Both white and red lead should be thoroughly tested for purity.

International Railway Congress.—The International Railway Congress, which is attended by representatives from all of the European railways, will hold its next session in London in the month of June, 1895. This next session will be the fifth, the preceding reunions having taken place at Brussels, Paris, Milan and St. Petersburg, having had its origin at the centennial celebration of the introduction of railways in Belgium, to which a great number of railway men were invited. This reunion was so successful that it was decided to create a permanent organization for the purpose of organizing others in different centers of railway activity. The permanent office of the commission is at Brussels, and it is composed of 30 members renewed in thirds at each session. The association is certainly very unique, and seems admirably organized for obtaining the maximum results at the work of the session. The present President is Sir Andrew Fairburn, General Manager of the Great Northern Railway of England, and member of the Executive Committee. The Vice-President is Mr. Emlyn, Vice-President of the Great Western Railway, and the Secretary is W. W. Ackworth. The association of English railways, who have appointed a special committee for the reception of the guests in great number, have selected Mr. Ackworth as secretary of this committee, and upon him will fall the greater part of the duties of taking charge of the concourse.

Civil Engineers' Society of St. Paul.—At a meeting held on May 7 Mr. O. Claussen read a paper on the Requirements of Municipal Electric Light Plant Installation, advocating the location of the power house near a plentiful supply of water, in order that compound condensing engines might be used, and yet far enough from the business center to escape excessive cost of real estate, while near enough to profit by transportation facilities. Tiled floors were recommended for the engine and dynamo rooms, with rubber mats that were to be placed where necessary for protective insulation. A traveling crane as a fixture would assist in handling the equipment. The machinery and foundations were to be massive and of hard-burned brick laid in Portland cement. He favored low speed triple-expansion engines, water-tube boilers, extra feed pump capacity, economizers and smoke consumers. Steam pipes were to be furnished with magnesia casing and fitted with numerous valves in case of accident.

Association of Engineers of Virginia.—At a meeting on April 18 Mr. G. R. Henderson read a paper on boiler construction, in which he gave an interesting description of a modern boiler plant, where a short stack with a fan was used to regulate the draft instead of the usual very expensive stack, and where the fuel was not handled except by the mechanical means after it was dumped by the teamster until the ashes were let into the cart to be taken away. Also of the latest designs of water-tube boilers, showing the novelties of their

construction. Novelties of details were also given, among them a description of the Serves ribbed tubes, accompanied by an extract of a paper read by M. Kéromnès before the French Society of Civil Engineers, which showed an economy, in a locomotive test, of from 15 to 20 per cent. for the Serves tubes over the smooth tubes. The large excess in first cost will probably prevent their early introduction in this country except where fuel is very dear.

Engineers' Club of Cincinnati.—At a recent meeting Mr. C. Wood, Chief Engineer of the Cincinnati, Hamilton & Dayton Railroad, read a paper on the construction of a new freight house recently built by his Company at Cincinnati for outbound business. The principal building, and an additional covered platform of brick pavement, are constructed of ironwork, having posts of four angles latticed, resting in cast-iron shoes filled with concrete, purlins, trusses, and all parts of iron. The sides above the sash over the doors and the roof are covered with galvanized iron. Floor of 3-in. oak stringers bedded in cinders. Rolling steel shutters made in two 10-ft. parts in 20-ft. space, with the post between hung on pivot so as to allow of being swung back, thus making opening 20 ft. clear.

Engineers' Club of St. Louis.—At a meeting of April 11 Mr. J. A. Laird read a paper on the new machinery being installed at the water-works. In referring to the details of the pumping engines, he said that the shaft of the high-service engine No. 6 is of nickel steel 92,000 lbs. tensile strength and 22 per cent. elongation in four diameters. The capacity and duty tests on the Chain of Rock engines are to be for 720 consecutive hours. There is a 15-ton electric traveling crane in the engine house at the Chain of Rocks; vertical hoist, 80 ft. It has not caused a moment's delay in nine months' use, and is looked after and run by an ordinary helper. There are separate steam mains for each pair of engines. All feed-water will be metered. The running of the entire plant will be made as near as possible a perpetual duty trial.

American Railway Master Mechanics' Association.—The Secretary has sent out a final circular calling attention to the fact that the annual convention will meet at Saratoga, N. Y., at 9 A.M. June 18; the headquarters of the Association to be at Congress Hall. Members and others intending to be present should apply to Mr. H. S. Clemens, Congress Hall. The charge where no extras are furnished will be $3 for each person.

The Secretary has also issued another circular in which he states that there will be two vacancies for scholars at Stevens' Institute of Technology in September next. Sons of members and of deceased members only are eligible. Those desiring particulars of the entering examination will receive the same by writing to Angus Sinclair, 5 Beekman Street, New York.

Master Car-Builders' Association.—Secretary Cloud has sent out a circular calling attention to the announcement of the fact that the twenty-eighth annual convention of this Association will be held at Saratoga, with headquarters at Congress Hall, the first session of the convention to be called to order at 9 A.M. Tuesday, June 12. Members and others are again reminded that application for rooms should be addressed to A. H. Clements, Manager of Congress Hall, who has made arrangements for the usual accommodations to all in attendance at the rate of $3 per day.

Boston Society of Civil Engineers.—At a meeting held on April 18, Mr. A. L. Plimpton, Chief Engineer of the West End Street Railway Company, gave an interesting account of the experience that they had in welding tracks electrically, illustrating his remarks by blackboard sketches and specimens of welded joints.

PERSONALS.

THE title of Mr. E. W. GRIEVES, Master Car-Builder of the Baltimore & Ohio Railroad, has been changed to Superintendent of Car Department, with headquarters at Camden Station, Baltimore. The duties of the Superintendent of Car Department will be the same as those heretofore discharged by the Master Car-Builder, and he will report to the General Manager.

THE title of Mr. WALTER ANCKER, Supervisor of Floating Equipment on the same road, has been changed to Superintendent of Floating Equipment, with headquarters at Camden Station, Baltimore. In addition to the duties heretofore pertaining to the position of Supervisor of Floating Equipment, he will have charge of the repair and maintenance of the Company's wharf, dock, pier, and bulkhead properties.

MR. E. E. POSEY has been appointed General Passenger Agent of the Mobile & Ohio Railroad Company, with headquarters at Mobile, Ala. He will confer from time to time with the General Manager and General Auditor upon matters pertaining to the passenger department.

FRANCIS M. SIMONDS has opened a laboratory at 20 Platt Street, New York City, for purposes of making original investigations or experiments in chemical and metallurgical processes, including the analyzing and assaying of ores.

MR. EDWARD F. LUCE has been appointed General Agent of the Detroit Lubricating Company, with headquarters at Chicago, and the Chicago office has been removed from the Western Union Building to No. 941 Rookery Building.

MR. J. F. SCOTT, Master Car-builder of the Evans & Terre Haute Railroad Company, has resigned, and the office has been abolished. MR. JOHN TORRENCE has been appointed Superintendent of Motive Power and Rolling Stock. This order took effect on May 15.

STANDARD SPECIFICATIONS FOR STRUCTURAL STEEL.

By GEORGE H. THOMSON.

MATERIALS FOR STEEL BRIDGES.

GENERAL.—1. All of the materials used in the manufacture of the bridges shall fully and strictly conform to the several specifications as follows:

A. Specifications for raw materials.
B. Specifications for ingots.
C. Specifications for rolled steel.

2. The materials used in the manufacture of bridges shall be made from the raw materials to the finished product at one establishment.

3. The finished material shall not be shipped from the rolling mills until the Inspector of Rolled Steel has duly accepted and marked the same.

4. The Consulting Engineer reserves the right to reject all the steel from any special cast that has passed the requirement of three specifications above enumerated, provided, however, that three out of five specimens selected at random by him, from material rolled from said special cast shall show evidence of "piping" or lamination.

5. Materials for steel bridges shall be ordered upon bills approved by the Consulting Engineer. The contractor shall submit in triplicate form complete, correct, and legible bills, exhibiting the order numbers, name or number of bridge covered by the order, giving the location of the furnaces and mills where the ingots are cast and the steel is to be rolled. Should the Consulting Engineer approve the bills two copies shall be retained by him and one returned to the contractor.

6. The Consulting Engineer reserves the right to make such analysis, examinations, etc., on ingots and finished material, either physical or chemical, as he deems necessary to arrive at a thorough knowledge of the solidity of the ingots or the physical or chemical character of the rolled product; and the contractor shall furnish such pieces of identified finished material for examination as the Consulting Engineer may require.

7. The Consulting Engineer reserves the right to mark all rejected finished material with a permanent mark of identification.

8. The expense of inspection of the raw materials, the inspection of ingots, and the inspection of rolled steel, including the *record* and identification of the same, together with the cost of chemical and occasional microscopic work, shall be borne by the contractor. The inspectors shall be appointed by the Consulting Engineer.

9. These specifications throughout are subject to the interpretation of the Consulting Engineer.

SPECIFICATIONS FOR RAW MATERIALS USED IN THE MANUFACTURE OF STEEL FOR INGOTS.

1. All raw material used in the manufacture of steel ingots shall be chemically within the Bessemer limit of the following proportions of 1 per cent.:

Sulphur....	.05
Phosphorus	.10
Copper	.40

2. All raw materials shall be subject to the acceptance or rejection of the Inspector of Raw Materials.

3. The contractor shall furnish to the Inspector of Raw Materials complete and correct reports of all raw materials to be used in every heat prior to charging the same into the furnaces.

4. The Inspector of Raw Materials shall have free access at all times to all stock piles and other stores of raw materials, and the contractor is to furnish said inspector all reasonable data and facilities to assist him in the inspection and identification of all raw materials.

5. Rejected raw materials shall not be used in the manufacture of ingots.

SPECIFICATIONS FOR THE MANUFACTURE OF INGOTS.

1. All ingots must be cast from steel melted in an acid-lined open-hearth furnace.

2. The ingots shall be subject to the acceptance or rejection of the Inspector of Ingots.

3. No single ingot or casting shall (in order to avoid extreme segregation) exceed 15,000 lbs. in weight.

4. All ingots must be bottom cast.

5. No ingot shall be disturbed or removed from the position in which it is cast until it is sufficiently solidified to obviate "bleeding."

6. All ingots shall be duly marked for identification, and a complete and correct report of each cast, giving the number, size, and weight of each ingot, shall be furnished by the contractor to the Inspector of Ingots within five hours after the cast is made; and the contractor shall furnish said inspector such further data as he may require to assist him in keeping the record of the identity of the ingots.

7. The Inspector of Ingots shall have free access at all times to the works where the ingots are cast.

SPECIFICATIONS FOR ROLLED STEEL

1. Steel shall be rolled only from identified and duly accepted ingots.

2. Finished rolled steel shall show under analysis not more than the following proportions of 1 per cent.:

Phosphorus	.08
Sulphur	.04
Manganese	.45
Copper	.20

3. All finished rolled steel shall be straight, well finished in the rolling, full to dimensions and free from laminations, buckles, surface, edge, or other defects.

4. All finished rolled steel shall possess certain definite physical properties, which shall be determined by the Inspector of Rolled Steel from such test pieces (to be prepared by the contractor) as said inspector shall determine, as follows:

	Not less than lbs.	Not more than per sq. in.
Ultimate tensile strength plates and shapes	56,000	65,000
" " " rivet rod	50,000	54,000
Elastic limit plates and shapes	33,000	
Elongation plates and shapes under 36 in. wide 26 per cent. in 8 in. length.		
Elongation plates over 36 in. wide 24 per cent. in 8 in. length.		
Reduction of area plates and shapes 50 per cent.		
" rivet rod 60 " "		

5. The fractures of test pieces shall be mainly fine grained.

6. Finished rivet rod when heated to a red heat and upset for 8 in. of metal shall show (upon cutting out) a silky fracture.

7. Strips of finished material cut along the direction of rolling shall withstand cold bending, double upon itself under the hammer without visible cracking.

8. Prepared specimens cut from finished material at random shall show no "piping."

GAGNIER-GRIFFIN SUSPENDED BRIDGE RAILWAY.

INSTRUCTIONS TO INSPECTORS.

1. The Inspector of Rolled Steel will take general charge of inspection, appointing the Inspector of Raw Materials and the Inspector of Ingots. He will examine and check all orders, shipments, reports, tests, and other examinations, etc. He will record all rejected raw material, ingots, and rolled steel, and notify the contractor of the causes for rejection of the same.

2. The Inspector of Rolled Steel will direct the work of the Inspector of the Raw Materials, and see that he is very familiar with the several grades of raw material in current use at open-hearth furnaces; that he makes inspections personally; and that he identifies inspected raw materials; that he is on duty day and night when required; and that he turns over to the Inspector of Ingots a correct certificate and record of all identified raw materials accepted or rejected by him.

3. The Inspector of Rolled Steel will direct the work of the Inspector of Ingots and see that he is familiar with the work of the furnaces, the uniformity of the product, etc.; that he traces the raw materials to the charging of the same into the furnaces, and thence to the ingots, and thence to the mills, reporting the same to the Inspector of Rolled Steel; that he is on duty day and night when required; that he rejects "bled" ingots, or ingots not bottom cast; that he notes especially casts that have been too violently or quickly melted or burnt, and that he reports the same for special examination of steel rolled therefrom.

4. The Inspectors of Rolled Steel personally will inspect the rolling of material only from traced ingots, and he will from time to time test for the properties, chemical and physical, called for under the specifications for rolled steel. He will be on duty at all times required.

5. The Inspector of Rolled Steel shall establish and assign a value to all rolled steel inspected by him, and shall then record this value. Rolled steel which has been accepted by him as satisfying all the requirements of the specifications for rolled steel traced to accepted raw materials and ingots shall have an assigned value of 100.

Rolled steel which, more or less, fails to meet the requirement of the three specifications shall have an assigned value ascertained by the following rating :

For steel traced to accepted raw materials	15
" " " " ingots	15
" " satisfying clause 2d specifications rolled steel	10
" " " " 3d " " "	10
" " " " 4th " " "	30
" " " " 5th " " "	10
" " " " 7th " " "	10
Total	100

THE MOFFET PORTABLE DRILL.

In which clause 4th is divided into	Ultimate strength	5
	Elastic limit	15
	Elongation	5
	Reduction of area	5

6. The Inspector of Rolled Steel will accept all steel valued at 100 and reject all steel of less value.

7. The Inspector of Rolled Steel will not accept satisfactory testing machine results as conclusive evidence of the quality of the steel inspected further than its rating of 30 ; machine tests are to be considered as corroborative only, and of no value considered alone. All of the requirements of the specifications must be satisfied, and the whole taken together shall be the absolute criterion establishing the value of the steel before acceptance.

". . . any test is liable to yield untrue results, either from incapacity or carelessness in those who use it."—*Herbert Spencer.*

Manufactures.

SUSPENSION RAILWAY AT KNOXVILLE.

There is a novel method of crossing the Tennessee River in use at Knoxville, Tenn., which was constructed by the Gagnier-Griffin Suspended Railway Bridge Company, of Chicago, Ill. It is an aerial rope tramway on the property of the Unakas Park Company. The tramway consists of two 1¼ in. cables stretched from the shore of the river at the terminus of the West End Railway upward to a bluff on the opposite bank 350 ft. above the starting point, the length of the span being 1,060 ft., making a grade of about 33 per cent. These cables form rails upon which the cradle travels, being hauled to and fro by a 20-H.P. engine located in the power house at the lower end of the cable. These cables are anchored at the lower end or Knoxville side by being bolted to 12 × 12-in. bolt timbers 14 ft. long, placed behind partitions of 6-ft. plank.

The connecting bars are 12 ft. long and 1½ in. thick. The staples to which the cables are fastened have 24 in. of thread to take up this slack. The hauling cable is a ¾-in. wire rope, and is permanently fastened to the car. The anchor at the upper end is made of iron plates fastened to the solid rock. The supporting cables have a breaking strength of 60 tons.

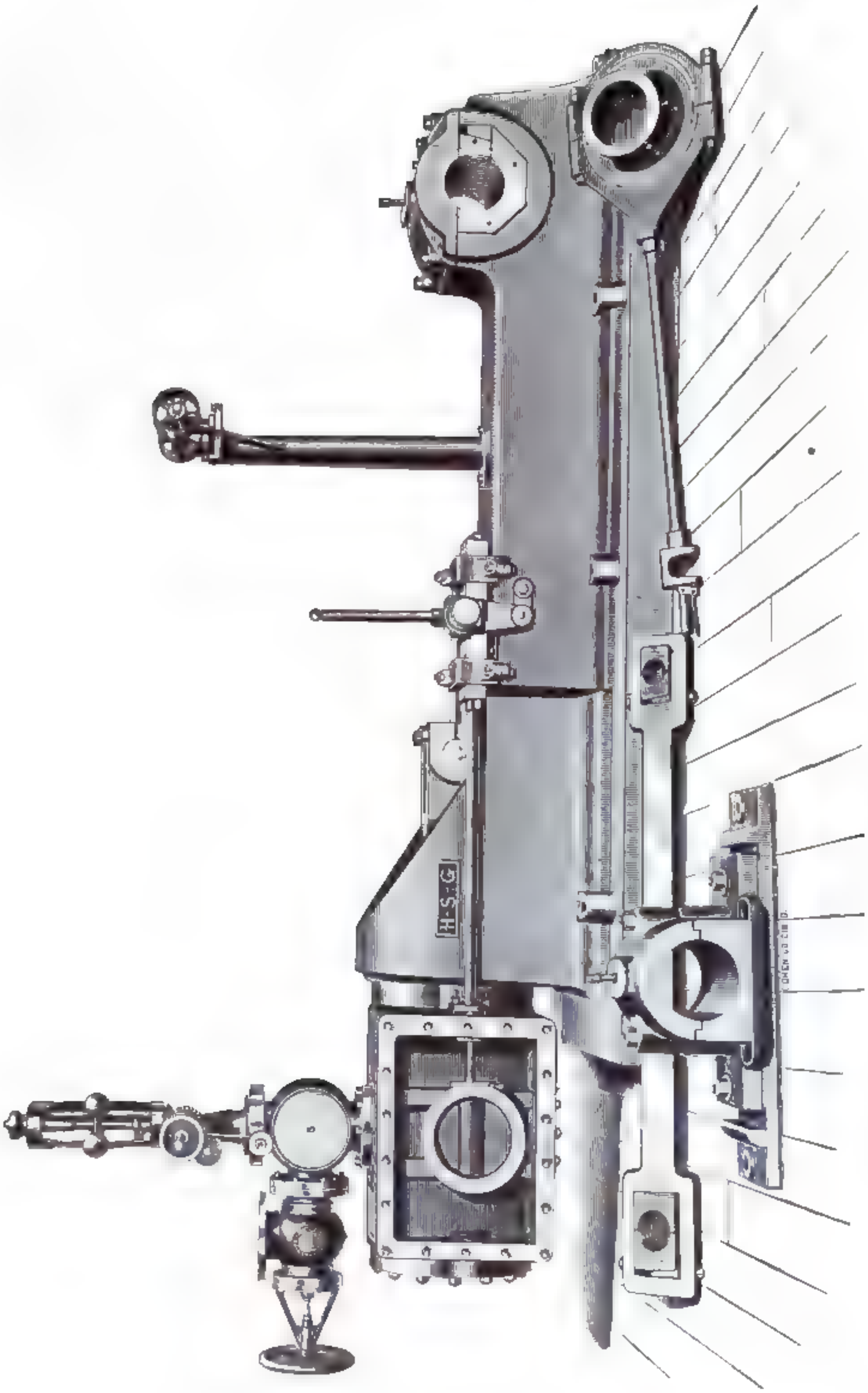
The upward trip consumes about 3½ minutes, while the descent only requires ½ a minute, the car running down by gravity The empty car weighs 1,200 lbs., has a 14-ft. body, and 3 ft. platforms 6 ft. wide and 6½ ft. high, with a seating capacity for 16 passengers.

This road merely exemplifies one of the many purposes for which the system designed by G. H. Griffin is excellently suited, and can be used in many industries as well as for pleasure resorts and mountain climbing. To mention the number of applications which might be made it would be merely recapitulating all of the work which is necessary to be done in mountain fastnesses for the transportation of freight and passengers. It is claimed that this bridge can be built up to 3,300 ft. without support. The factor of safety used in the construction of the system is eight to one, and the cars are provided with all the requisite appliances for insuring stop pages at the right place. It is certainly a novel and daring piece of engineering, and one which, in its construction and operation, will certainly attract a great deal of attention.

THE MOFFET PORTABLE DRILL.

The accompanying illustration represents a very convenient form of portable drill manufactured by J. G. Timolat, of 89-91 South Fifth Avenue, New York. The drill consists of a small rotary engine connected by steel gears with a drill spindle carrying a taper socket at one extremity. The tool is intended to do away with the tedious operations of drilling with the ratchet, and the power applied can be either steam or compressed air at a pressure of not less than from 40 to 45 lbs.

The connection between the drill and the steam or air pipe is made by means of flexible hose, the length of which determines the area within which the drill can be operated. The drill is fastened to the work in the same manner as a ratchet drill, and as it weighs but 45 lbs. this can be readily done. The capacity of the drill ranges from holes of ⅛ in. to 2½ in. in diameter, in steel, wrought or cast iron ; the speed for the different sizes of drills being regulated by the feed-valves and feed-screw without reducing the power below a satisfactory working point. When used as a reamer the weight of the tool carries the cutter through if it is operated vertically, and but a slight pressure is necessary for horizontal work.



DETAIL OF HEAVY-DUTY ENGINE. MANUFACTURED BY HOUSTON, STANWOOD & GAMBLE, CINCINNATI, OHIO.

A HEAVY-DUTY SLIDE-VALVE ENGINE.

We here illustrate a new heavy duty slide-valve engine manufactured in Cincinnati, O., by Houston, Stanwood & Gamble.

This engine is one of a series of large size engines which this firm terms "heavy-duty engines," on account of the large bearings and heavy design. These engines are used to a great extent in distilleries, planing mills, sawmills, rolling mills, and even in electric-light plants in localities where fuel is cheap.

Fig. 1 is a rear view of the engine dismantled, showing balanced slide valve, form of connecting and eccentric-rods, and the removable main bearing.

Fig. 2 shows a cross section of the bed taken through the slides. These slides are adjustable and removable, top and bottom, so that in case of excessive wear the slide bars may be taken out and planed at any machine shop. The cross head, which has a babbitted bearing on top and bottom slides, is very heavy and has a large pin. This pin is of steel and is turned perfectly straight, and is secured in a straight hole which is carefully bored and reamed, and into which it is clamped by studs as shown. An end view of the valve stem guide is also shown in this cut. This guide, as well as the valve bar, is made of cast iron, and possesses large wearing surface.

Fig. 3 is a side view of the main bearing, which is so constructed that it may be removed without lifting the shaft and fly-wheel out. In doing this the eccentric is first moved laterally on the shaft, and the shaft, crank and wheel being raised slightly, enables the box to be withdrawn by means of hand-screws inserted in the holes shown in cut.

The cylinder has large ports 9 per cent. of the area of the piston. The travel of valve being large gives an excellent distribution of steam.

Fig. 4 is a sectional view of the slide-valve partially balanced. On the back of the valve is a plain ring bearing against planed surface on the inside of the steam-chest cap, which also embraces a round plug turned on back of valve. The joint between plug and ring is made tight by a plain spring packing ring. There is a hole on the back of the valve which connects with the exhaust passages of the engine, relieving the valve of pressure in this inner chamber.

Fig. 5 is a section of the piston. The packing is of Babbitt-Harris type, which has done such good service in Corliss engines for years. A peculiar feature of this piston is the junk ring, which is as wide as the piston. If the cylinder has to be re-bored, the owner does not have to purchase an entirely new piston, but simply the junk ring with its packing.

These heavy-duty engines are manufactured in the following sizes: 17 in. × 24 in., 18 in. × 26 in., 20 in. × 28 in., 22 in. × 30 in., and have heavy fly-wheels and large size governors. This firm makes a specialty of manufacturing slide-valve engines from 10 H.P. to 250 H.P. A "Ready Reference Book for Steam Users," which is of interest to all engineers, will be sent on application.

L. S. G. GRAPHITE PAINT.

The Detroit Graphite Manufacturing Company are manufacturing a protective paint for wood and iron, which is composed of a natural product mined in the Lake Superior region of Michigan. This product is ground by special machinery which produces a pigment of extreme fineness and smoothness, and which is claimed to be absolutely uniform. As graphite is not affected by salt, acid, alkalies, or ordinary gases, it makes one of the best foundations possible for preservative paints. This special paint has been subjected for months to acids, alkalies, water, brine, sulphur fumes, etc., and it is guaranteed to be a sure protection against rust or corrosion of any metallic portions painted with it, under any circumstances and in any climate. The natural color is a very dark slate approaching a steel black, but it can be furnished in dark

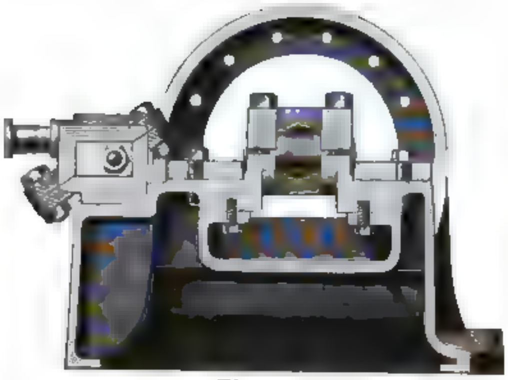


Fig. 2.

green, slate or brown, to black, suitable for regular surface painting and trimming for buildings. It is also claimed that wood painted with it and exposed to heat would char beneath

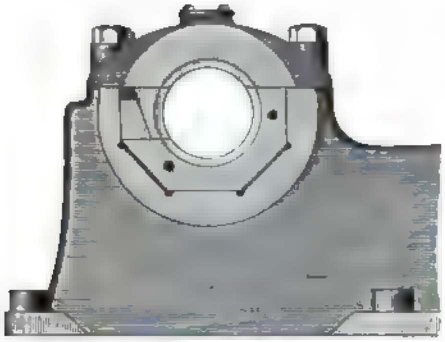


Fig. 3.

without burning the paint. Another feature which is very valuable, is that it is tenacious and elastic and will not scale off from metal, wood, brick or slate surfaces, while it con-

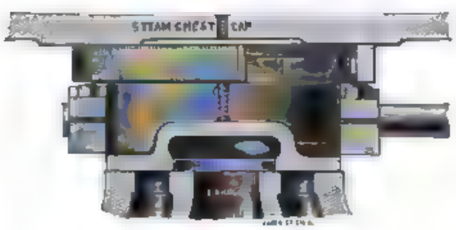


Fig. 4.

forms to the expansion and contraction of the metals painted with it.

The illustration which we present shows a common 2-bushel grain bag painted with this graphite paint in July, 1892, and which has been kept constantly filled with water ever since, without leaking. The bag is still soft and pliable, and although it has twice been frozen solid, it is still in a perfect condition. Not a drop of water has leaked, and it is apparently good for many years more of similar service. This is considered as the best of evidence of the waterproof and preservative qualities of this graphite paint.

Fig. 5.

Another adaptation of the paint is the coating of boiler flues. About a year ago several flues were given a coat, and although it was thought at the time that they would not last six months, when examined a short time ago they were found to be in as perfect condition as when painted, while other flues in the same boiler, which had not been touched with the graphite, were badly corroded and scaled. The painted flues, on the other hand, had a clean and almost polished surface, to which it seems impossible for scale to adhere. This merely corroborates some of our own experience where the marks on boiler sheets stood

GRAIN BAG PAINTED WITH L. S. G. GRAPHITE PAINT.

out prominently and untouched by corrosion after several years of service, while the parts of the sheet which had not been touched with the marking paint were badly corroded and pitted, leaving the original marking projecting in a bold bas-relief.

EXPERIMENTS WITH SERVE TUBES MADE ON THE NORTHERN RAILWAY OF FRANCE.

By Kéromnès.

The Serve tubes are now being largely introduced in marine boilers, and have been for some time in use on locomotives of the Paris, Lyons & Marseilles Railway in France. The results of their trial on that railway were so satisfactory that the Northern Railway adopted them for three locomotives whose tube plates required renewal, and for 15 new locomotives under construction at Belfort, and the results obtained were excellent. The Serve tube differs from ordinary tubes in having eight internal radial ribs which serve to increase the heating surface.

The Northern Railway, in their first trials of these tubes, followed the example of the Paris, Lyons & Marseilles Company in using tubes of 2¾ in. diameter instead of the smooth tubes of 2 in. previously in use. The number of tubes was greatly reduced, in some cases by one-half, while the heating

surface was at the same time largely increased, and the total section of the tubes open to the passage of the gases somewhat increased also. The surface in contact with the water was of course reduced, a matter of no consequence, since it is in any case greater than is necessary to transmit the heat at the rate at which it is taken up from the gases.

These trials being so satisfactory, it became a question whether Serve tubes of 2 in. diameter could not also be made to serve, since, if not, they could not be introduced except where new tube-plates were wanted. The experiments to which this paper is devoted were therefore undertaken. They were made with a stationary boiler of locomotive type, forming one of a group of four at the railway workshops of Forges de la Chapelle. Two fans, driven by Brotherhood engines, were used to represent the effect of the blast. The grate had an area of 14.4 sq. ft.; the tubes were 160 in number, 1.97 in. in diameter, and 14.65 ft. in length. The heating surface in the furnace was 82 sq. ft., and in the tubes (before alteration) 1,151 sq. ft.; the steam pressure was 92.4 lbs. per square inch. The boiler under trial was tested alone, and also when working along with the other boilers.

The first Serve tubes tried had ribs of a depth of 0.48 in., which raised the heating surface from 1,233 sq. ft. to 2,336 sq. ft., but reduced the section open to the passage of the gases from 2.84 sq. ft. to 2.56 sq. ft. With natural draft the vaporization per pound of coal was very slightly increased, the same amount of steam being made in the day with a somewhat reduced consumption. With forced draft, however, the production of steam per pound of coal was increased by as much as one-eighth, the best effect being got with a vacuum lying somewhere between 1½ and 2½ in. of water. The temperature in the smoke-box was lowered from 518° F. (with smooth tubes) to 388°. The temperature of the steam being 322°, it is seen that very little more use could possibly have been made of the combustion. The objection, however, to this experiment was that the tubes got often choked with ashes; and therefore a tube of 2.05 in. diameter was tried with ribs 0.35 in. in depth, the ribs extending to a length of 8.2 ft. only, and the rest of the tube being smooth. The section for the passage of gases was now increased to 2.69 sq. ft., and less choking of the tubes occurred; the efficiency was much the same as in the preceding case. Tubes of the same size were therefore tried with ribs of 0.275 in. projection, both extending the whole length of the tube, and also for a length of 8.2 ft. only. The results were much the same, whether the rib was of the full length of the tube or not, and showed a vaporization of 25 per cent. in excess of that of smooth tubes for the same amount of fuel, with a draft of 3 in. water pressure.

With tubes of this depth all difficulty as to choking disappeared. With the shallower ribs it was found that a greater draft gave maximum economy than with deeper ribs. The tubes used in these trials have now been fitted on two locomotives under repair, with an increase of weight in one case of 154 lbs., and in the other of 220 lbs. Fresh experiments will be made with them in service.—*Mémoires et compte rendu de la Société des Ingénieurs-civil.*

Recent Patents.

LOCOMOTIVE.

MR. RICHARD HELMHOLTZ, of Königsberg, Germany, has taken an American patent on the ingenious plan of locomotive illustrated by figs. 1, 2, 3, 4 and 5. Fig. 1 is a diagrammatic view, showing the general arrangement of parts; fig. 2 is a side view of the front part of the locomotive; fig. 3, a transverse section through the smoke-box on two different planes, and fig. 4 a sectional half plan of the part of the engine shown in fig. 2.

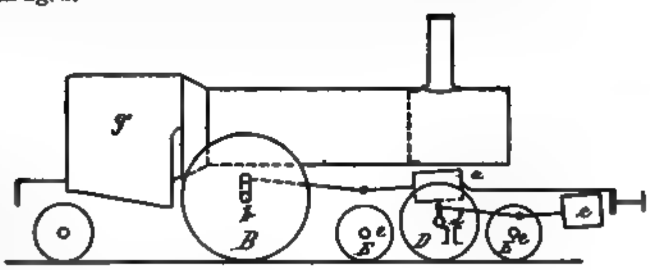


Fig. 1.

The objects and advantages of this invention are described as follows in the specification:

"In locomotives of ordinary construction having two pairs of drivers driven from one pair of cylinders, the dimensions of such cylinders must be such as to produce the maximum hauling power, which corresponds, as is well known, to the total weight resting upon the drivers. This construction has the objection that when a certain velocity is attained, the coupling of the drivers becomes superfluous, for the reason that the adhesion of one pair of drivers would be sufficient for the hauling power determined by the surface of evaporation of the boiler. Otherwise, smaller cylinders would, at these velocities, give better results than the dimensions calculated for the maximum hauling power. These two items: first, the heavier running of the drivers consequent on their being coupled, and second, the excessive dimensions of the steam cylinders, exert

Fig. 2.

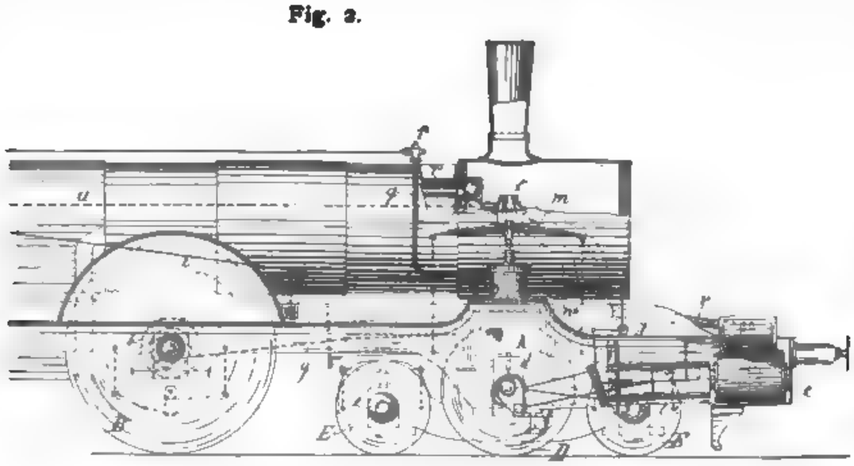
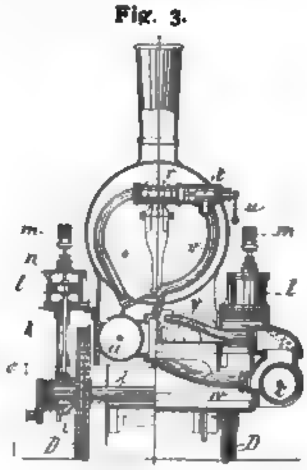


Fig. 3.



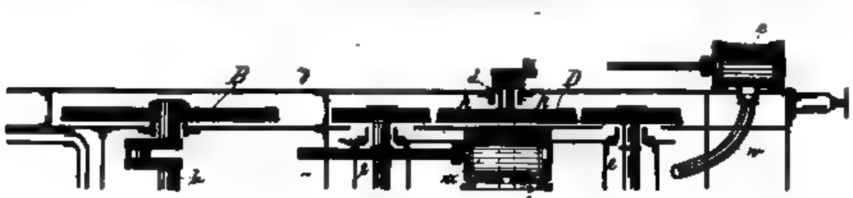


Fig 4.

unfavorable influences on the working of the engine, and for this reason the best results at high velocity as well as the highest absolute velocities have been attained heretofore by uncoupled drivers or locomotives having but one pair of drivers.

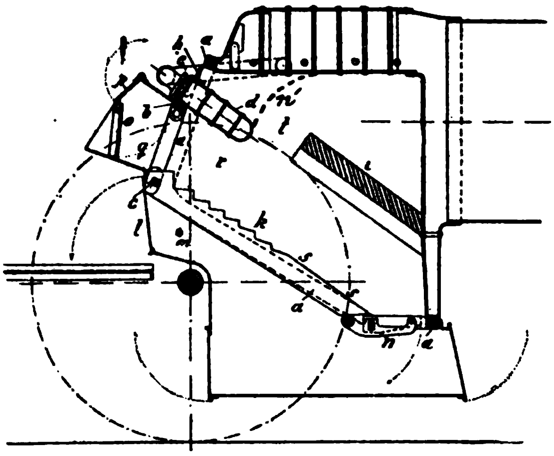


Fig. 5.

The use of such engines is, however, usually inconvenient by reason of the low hauling power of such engines.

The object of the present invention is to unite the advantages of the locomotive having uncoupled drivers whereby great velocity may be attained, with those of the locomotive having coupled drivers whereby great hauling power is imparted.

In the drawings *B* represents the main drivers driven from the main cylinders *a*, as seen in fig. 1, and *D* represents the auxiliary drivers driven from the auxiliary cylinders *c*. The main engine, with its inner cylinders *a* and the driven axle *b*, is provided with very large drivers, to be operated at all velocities, while the auxiliary engine, comprising the external cylinders *c* and driving axle *d*, is provided with driving-wheels of small diameter, and is intended to increase the hauling capacity of the locomotive. For this purpose I have provided means whereby the auxiliary engine may be stopped when the speed reaches the limit, and have also provided means whereby the forward driving-wheels *D* and their axle *d* may in such cases be raised clear of the track in order to reduce the load on the main cylinders. The axle *d* is placed between two axles *e e* of bearing truck wheels *E* properly united to a swinging or pivoted frame of well-known construction (seen in fig. 4) pivoted on a pin, *f*, to the main frame *g* of the engine.

The drawings show that the supplementary axle *d* is attached to bearings or jaws *h h* on the main frame, although it is not so described in the specifications, and the boxes slide vertically in the ordinary manner between them. The bearings *i* (fig. 3) of shaft or axle *d* are firmly connected with the spring actuated or elastic supports *k*. These spring supports *k* are in the nature of piston-rods, and bear pistons *n* arranged in the cylinders *l* through which they pass through stuffing-boxes in the ends thereof, and are connected to the leaf springs *m* (figs. 2 and 3); such springs being supported from the frame in any convenient manner are tensioned upwardly in order to keep the driving-wheels *D* normally lifted free from the track for a distance marked *o* in fig. 3 of the drawings. By means of a three-way cock *p* (fig. 2) and the pipes *q* steam is admitted to the space above the pistons in cylinders *l*, or said space is placed in communication with the atmosphere. The admission of steam thereinto has, as will be obvious, the effect of depressing the drivers *D* into contact with the rails.

The driving-wheels *D* are represented as having flanges, but these would not appear to be needed, as the truck would guide the engine and keep it on the track.

The patent has been assigned to the "Locomotiv Fabrik of Krauss & Company, Aktien-Gesellschaft," of Munich, and is numbered 516,436. The inventor also shows an application of his device to an engine with two pairs of driving-wheels.

VON DORMUS' LOCOMOTIVE FIRE-BOX.

Fig. 5 represents a form of fire-box and grate that has recently been patented in this and several European countries. The whole back end of the fire-box, it will be seen, is open, or, rather, is without a water space. Immediately over the furnace door or doors—for there are two of them—is a water leg, *d*. This is connected by pipes *e* with the sides of the fire-box, whereby the steam generated in the arch is conducted to the boiler and a circulation of water is maintained therein. Immediately below the water-leg a feed-box, *q*, is located. This has two doors, *p* and *o*; the former is just large enough to feed coal into the box and the latter extends the whole width of the fire-box, so as to facilitate the use of fire tools in working the fire. A door, *l*, gives access to the ash pan, and enables the fireman to rake out the ashes from the under side of the grate. The grate, it will be seen, has steps at its upper end, and is straight at its lower. These steps are intended to retain the coal until it is coked, and the grate is made straight at its lower end, so that when the coal is coked it will slide downward to the front end of the fire-box; *i* is a fire-brick arch of the usual form. The water-leg *d* acts as a deflector for the air, which may be admitted through the door *p*. The connection of this arch with the sides of the fire-box by outside pipes will not, it is thought, commend itself to locomotive superintendents. It seems as though a better method of construction would be to bring the crown-plate down, as indicated by the dotted line *n'*, which has been added to the patent drawing; the space *d* would then be connected directly with the inside of the boiler.

The general idea of this invention is to supply a feed-box which can be kept filled with coal, so that, when the door *p* is opened, there will be comparatively little air admitted, and that will be deflected downward over the fire. The coal in the feed-box will be heated and partially coked, and the volatile gases will then be distilled. As this process continues it will be fed downward on the grate, the lower portion of which will thus have a layer of incandescent smokeless fuel on it. The air passing through this will combine with the distilled gases when the two currents meet at *t*, and will thus be consumed.

Steeply inclined grates, similar to the one represented, never seem to have met with much favor in this country, and yet they seem to have much to recommend them. The patentee of this invention is Fritz Ritter von Dormus, of Florisdorf, Austria-Hungary. The number of his patent is 516,923.

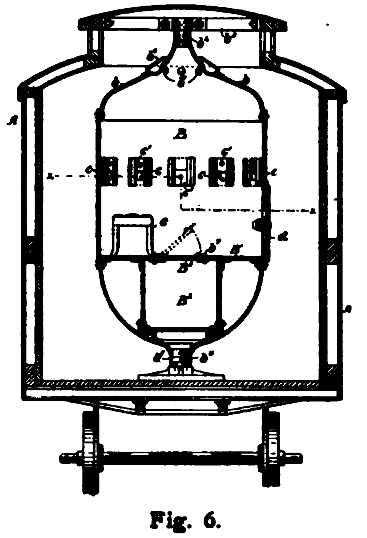


Fig. 6.

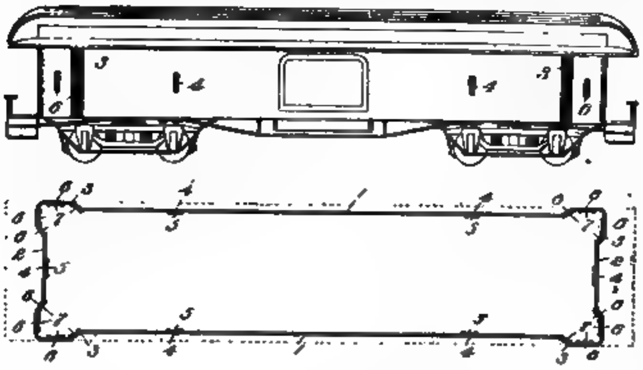
DEFENSIVE RAILROAD CAR.

Train robberies have become so frequent in this country that they have started inventors to provide means of prevention and defense. Mr. William D. Patterson, of Keokuk, Ia., has devised a means of defense against robbers which is shown in fig. 6. The objects of his invention he describes as follows: They are, first, to provide a railroad car with a simple, comparatively inexpensive, durable and safe apartment for a sentinel to be stationed, and with a vault connected therewith for the reception of valuables, whereby a practicably impregnable barrier is presented to the depredations of a class of outlaws or bandits that have become known as express and mail train robbers; and, second, to provide a railroad mail and money transportation car, with a compact burglar-proof apartment having a vault, and mounted in the car so as to permit of ready access being had to the interior thereof, and room afforded for passage along and around the apartment for entering the same, and having suitable ventilators and loop-holes and internal appliances to enable a sentinel or guard on watch therein to be prepared for any emergency that may arise, and

with fire-arms or the like so disposed and supported therein as to permit of their use when occasion arises through internally closed loop-holes of the apartment, the construction and arrangement being such as to render destruction of the apartment impossible or access to the interior exceedingly difficult.

Fig. 6 is a sectional view of a car and the "impregnable barrier" *B*, which is described as follows:

B is the shell of the burglar-proof apartment or chamber, which in this instance is in the form somewhat of a cage and constructed of iron, steel or other strong, impenetrable material, and having a contracted top, *b*, with radial apertures *b'* extending therethrough, and with a throat or stem, b^2, engaging with a cross bar, b^3, from the interior of the car from the top



Figs. 7 and 8.

thereof and for supporting said cage firmly to position; b^4 is a contracted hollow stem with a circular standard, b^5.

Suitable port-holes *c* with covers *c'*, a seat, *e*, etc., enable the occupant of this fort to act on the offensive as well as defensive. The patent is No. 517,234.

Another inventor—Mr. Owen G. Cates, Jr., of St. Louis, Mo.—has been working in the same direction. A side view and plan of his car is shown by figs. 7 and 8. His invention, he says, consists in the peculiar formation of the side and end walls thereof in such manner as to form bastions in one or more corners of the car, or, in other words, forming offsets in the side and end walls of the car, and providing these offsets with port-holes covered by slides on the inside, which can be raised by the occupant and give him command of all sides of the car, thus enabling him to protect the same from intruders in safety.

1 indicates the side walls of the car and 2 the end walls thereof. These side and end walls, for the greater part of their length, extend uninterruptedly, but near the corners are formed with offsets 8 projecting outwardly to a plane beyond, from which the side and end walls of the corners are led, thus forming "faces" of bastions, of which the offsets 8 form the "flanks."

Arranged at suitable distances apart along the length of the side and end walls, 1 and 2 respectively, are port holes 4 of a size sufficient for the introduction and passage of the barrel of a firm-arm, said port-holes being covered on the inside by slides 5 mounted in suitable ways. The offsets 8, or "flanks," and the "faces" of the corners of the car forming the bastions are similarly provided with port-holes 6 covered by suitable slides 7, as in the instance of the port-holes arranged along the side and end walls of the car. By the above arrangement it will be noticed that by the incorporation of the bastions in the car they do not detract from its symmetry, and the eaves of the car roof overhanging the same, these bastions offer no obstruction. It is also apparent that, if desired, offsets might also be arranged midway the length of the side walls, but this is hardly necessary in the present construction.

It would seem as though these two inventors ought to unite their interests. A car with Mr. Cates's "bastions" and Mr. Patterson's turret, with one or two courageous men who are good shots to form a garrison, would be a disagreeable place to attack.

CHECK VALVE.

Mr. Louis Schutte, of Philadelphia, has patented an invention which he says relates to horizontally moving check valves, the object being to provide a valve of this character which will be balanced so that the resistance offered to its opening and closing movements will be reduced to a minimum.

The invention consists primarily in combining with a valve seat, a horizontally moving valve adapted to close the same and sustained so as to be moved back and forth by links or equivalent supports pivotally connected to the valve on opposite sides of the same, and also in a stop constructed to limit the movement of the valve or to regulate the length of its "throw."

Fig. 1 is a vertical sectional elevation of a valve and casing having my invention embodied therein, the valve being closed and an adjustable stop being shown to regulate its movement. Fig. 2 is a similar view with the valve opened, a fixed stop being shown to limit its opening movement.

Referring to figs. 1 and 2, *A* represents a suitable casing containing a horizontal passage therethrough and provided with necks *a a'*, by means of which the casing may be connected between the adjacent ends of pipe sections, or may be applied in other connections according to the use to which the valve is put may require. This casing is provided at one side with a vertical valve seat, *B*, adapted to receive and be closed by a valve proper, *C*, thus closing the passage through the casing. The valve proper is provided at its center with oppositely extending flanges *c c'*, to which are connected by horizontal transverse pivots c^2 c^3, the upper and lower ends respectively of sustaining links *D D'*, the opposite ends of said links being pivoted on horizontal transverse axes to the valve casing at opposite sides of the valve, as shown at *d d'*.

From this description it will be seen that the valve is suspended, as it were, by the two oppositely extending links, this arrangement admitting of the movement of the valve horizontally. It will also be seen that the tendency of the valve to open and close will depend upon the relations of the center of gravity of the valve to the pivoted axes c^2 c^3 of the support, and by suitably proportioning the parts of the valve and adjusting the relations of the axes, and the center of gravity of the valve, the amount of pressure necessary to close or open the valve and the corresponding amount of resistance to its movements may be reduced to a minimum, so that the valve will be truly balanced and will respond quickly to the least variation of pressure on its opposite sides. It will also be noted that the movement of the center of gravity is practically in a straight line, as indicated at *E*. Its center of gravity moving thus, it will require, of course, less force to move the valve than it would if the center of gravity moved obliquely or in a path other than truly horizontal.

In order that the opening movement of the valve may be limited, I provide a stop, which is represented in fig. 1 as being adjustable, so that the movements of the valve may be regulated or varied. In this figure the upper side of the casing is provided with a depending boss, *F*, having a vertical

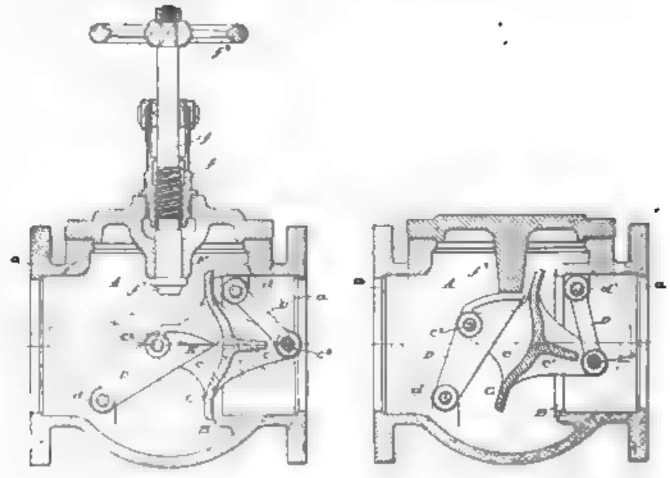


Fig. 1. Fig. 2.

SCHUTTE'S CHECK VALVE.

opening therein, on the upper side of which is fixed a neck, *f*, into which is threaded a spindle, *f'*, the lower end f^2 of which extends through the boss in the casing to the interior of the same. The upper end of the spindle is provided with a hand-wheel, f^3. The lower end of the spindle is in position to be encountered by the upper edge of the link *D* when the valve is opened, and by screwing the spindle down through the casing it is obvious that the end of the spindle may be adjusted in different positions to be encountered by the link, and thus vary the movement of the valve. In fig. 2 the stop is in the form of a fixed depending boss, f^4, projecting downward into the casing from its upper side in position to be encountered by the upper edge of the link *D*, as in the first instance.

The number of the patent is 516,407.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

Formerly the RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

The American Railroad Journal, founded in 1832, was consolidated with Van Nostrand's Engineering Magazine, 1887, forming the Railroad and Engineering Journal, the name of which was changed to the American Engineer and Railroad Journal, January, 1893.

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NEW YORK, JULY, 1894.

EDITORIAL NOTE.

As we go to press a report is at hand regarding some remarkable results that have been obtained at the Indian Head Proving Grounds with the Carpenter shells. It seems that a 13 in. projectile, weighing 1,100 lbs., has been fired through a 17-in. nickel steel plate with its customary backing, and after plowing through the sand butts against which the plate was placed, was finally recovered unbroken and to all intents as good as new in the woods, 500 yards away. This remarkable performance shows what a tremendous engine of destruction the Government has secured in the new 13-in. gun that has been nick named the *Peacemaker*. The result of these tests leads one to believe that it could drive a missile through the armor plating of the heaviest battle ship afloat.

THE CONVENTIONS OF THE MASTER CAR-BUILDERS' AND MASTER MECHANICS' ASSOCIATIONS.

After writing an annual editorial on these meetings for more than twenty years, a writer does not find it easy to say anything new or original about them. After an existence of more than a quarter of a century, these associations conduct their proceedings very much in the same way now as they did at first. There has been, of course, much change in the *personnel* of the attendance. Year by year the old members have been thinned out, and when we review the ranks there are many vacancies, but still more new recruits. A person on the descending side of life's journey, with one foot in the fifties and the other uplifted to be planted next in the sixties, who a quarter of a century ago was very much the junior of those who organized and carried on the business of the associations, now finds himself in the shade among the seniors, the great bulk of the membership being on the sunny side of fifty.

But while there is no radical change there has been much improvement in the methods of conducting the business of these organizations. The influence of the graduates of the technical schools is shown more and more each year. The reports are prepared more systematically, which is the result of the knowledge and training which scientific education gives. In some ways, though, the influence of the more liberally educated members has not been without some drawbacks. The older, and many of the younger men who have risen from the ranks now often hesitate to take part in the discussions. One of the profitable features of these meetings was that the men who acquired their knowledge directly from practical experience gave the results of their observations in the clear and concise way that is characteristic of their class. Book knowledge can never entirely displace this kind of information. In fact, knowledge, like matter, may be divided into three kinds—solid, liquid and gaseous. The practical men generally contribute the solid variety. The liquid information comes from those whose principal stock has been obtained from books, and the gaseous from the chronic windbags. When a graduate first leaves a technical school his contributions to the subjects about which he has been instructed is very apt to be of the liquid variety, and it is only after considerable experience that the fluid becomes solidified. Generally a chemical change is required before the contents of a gas-bag can be consolidated.

Probably very few of the people who attend these meetings and who have a real interest in their proceedings ever leave them without feeling that they have failed to accomplish what might reasonably be expected of them, and that reform and improvement ought not to be difficult. All who have undertaken to make any great changes have, however, been vanquished in the effort, and, as has been said, the meetings are conducted now in very much the same way as they were twenty-five years ago. The attendance is larger, it is true, and the general conduct of those who are present is more decorous than it was in the early days, but otherwise a report of the proceedings of one of the meetings held in the seventies is very much like one held in the nineties. There are, though, some things which it would seem possible to improve, and which, if they were so changed, would add immensely to the interest and value of the proceedings. We will venture to suggest a few of these.

It has been said of the British Parliament, and is equally true of all other legislative bodies, that it is essentially a deliberative or a *talking* body. The purpose of such assemblages is chiefly to deliberate—that is, to consider various subjects—and by having every important fact, relation, aspect and argument concerning such subjects presented, to enable those who are deliberating to form the most intelligent opinions and come to the wisest conclusions. Deliberation means talk. Everything should therefore be done to facilitate it and to make it effective. It is, of course, true that wise and intelligent discussion is edifying, while foolish and ignorant vaporing is unprofitable; and the aim of deliberation should be to elicit wisdom and knowledge, but these will only be revealed by discussion. The object of both of the associations, as expressed by their constitutions, is "the advancement of knowledge . . . by *discussions* in common." Notwithstanding this fact, it is curious to notice that many of the members seem to feel that discussion is a waste of time and merely a kind of safety-valve for letting off the steam of the more loquacious members. Over and over again it has happened during the last and other conventions that just when a discussion had reached a point where it began to be interesting, and when it was quite certain to lead to the elucidation of valuable information, some member would move "that the discussion be now closed," and the vote would be taken thereon, and nine times out of ten the gag rule would

be adopted, and, no matter how much members desired to speak, the debate was ended. George Eliot has said that "comprehensive talkers are apt to be tiresome when we are not athirst for information." Now, it happens that there is hardly a subject which can be brought up for discussion, no matter what its importance may be, that will interest the whole audience. There will always be some who will not "be athirst for information;" and, under the existing rules and practices, it is nearly always possible for such people to end the discussion of a subject, no matter how much others may want to get and to give information about it. Some amendment to the rules of procedure, or the practice of conducting debates, seems to be needed. In order that members may vote intelligently on a motion to close a debate, it should be known to the Association whether any of them, and which ones, wish to speak on the question before the house. If, when a motion is made to close debate, the question, "Are there any other members who desire to speak ?" was asked before a vote is taken thereon, then, if any persons whose general intelligence and knowledge of the subject would entitle them to be heard should indicate a desire to speak, it might incline others to give them an opportunity to do so. If, on the other hand, some of the tiresome and fatuous variety of talkers should want to express their views, it probably would induce members to vote to have the debate ended. If a rule were adopted that before a motion to close debate be put, the chairman should first ask whether any other members desire to be heard, and that an opportunity should be allowed those who wish to speak to say so, and that a vote be then taken on the motion, it would give the members an opportunity of knowing whether any persons who are worth listening to had anything to say before the debate is finished.

Another interference with discussion at the last meeting—and a similar cause of disturbance has existed at nearly all previous meetings—was the bad acoustic character of the room in which the meetings were held. A very large proportion of the audience could not hear half of the proceedings. Members grew tired, lost interest in the proceedings, and either left the room or moved "that the discussion be closed," and thus ended as soon as they could the dumb show. The meeting was often disturbed by the people who had exhibits, which were being either packed or unpacked during the sessions of the conventions. The noisy band which played every morning was placed so near to the meeting-room that it also interfered seriously with the proceedings. Probably the total expense of holding each of the conventions was over $100,000, and yet their main purpose was largely defeated by the fact that the room in which they were held was not suited for such meetings. The Saratoga people have built a large convention hall which will hold several thousand people, but for that reason it is not suited for meetings of two or three hundred. What is needed, then, is a small room capable of seating about three hundred people, located where there would be no danger of disturbance by noise, and arranged with special reference to meetings of technical and scientific associations. If placed in the middle of Congress Spring Park, it would be in an ideal location. Such a hall would make Saratoga a much more desirable place for holding meetings of this kind than it now is, and doubtless would do much to attract associations of that kind to its hospitable hotels and aperient springs.

Another reform in the Master Mechanics' Association which is very much needed is to make the Secretary an appointee by the Board of Direction instead of an elective officer. On the last day of the session of that body there was an unseemly scramble for the place, in which the methods of the ward politicians were imitated too closely to increase the good repute of the Association. The following is the clause of the Master Car Builders' constitution for the appointment of the Secretary :

"A Secretary, who may or may not be a member of the Association, shall be appointed by a majority of the Executive Committee at its first meeting after the annual election, or as soon thereafter as the votes of a majority of the members of the Executive Committee can be secured for a candidate. The term of office of the Secretary thus appointed, unless terminated sooner, shall cease at the first meeting, after the next annual election succeeding his appointment of the Executive Committee, organized for the transaction of business. Two thirds of the members of the Executive Committee shall, however, have power to remove the Secretary at any time. His compensation, if any, shall be fixed for the time that he holds office, by a vote of a majority of the Executive Committee. He shall also act as Secretary of the Executive Committee."

It seems obvious, without any argument, that those who are on the Executive Committee of an association of this kind will be better judges of the qualifications and efficiency of a secretary than the members generally can or will be. A better secretary is therefore likely to be selected if he is appointed in this way than if he is elected. Ever since this clause was adopted by the Car Builders' Association there have been no such scandals as those to which the American Society of Civil Engineers and the Master Mechanics' Association are subject periodically. In the American Society of Mechanical Engineers the Secretary is also appointed, and there has been no trouble there and the Association has been served acceptably.

There is also another reason for making the Secretary an appointee of the Board of Direction and not an elective officer, which is, that the self-respect of a person entirely competent for the office is likely to prevent him from entering into an indecorous contest for the place, whereas if it were offered him by the Board it would be regarded as an honor and could be accepted without loss of dignity.

There was again considerable discussion this year of the question of the consolidation of the two associations, and it was recommended in the address of the President of the Master Mechanics' Association, but was again strongly opposed by many of the car builders. Inasmuch as all the advantages of consolidation could be gained without it, it would seem to be wise to avoid exciting the opposition which that measure always arouses. This year the Master Mechanics held their first meeting on Monday morning, and the attendance was very good. It used to be thought that it would not be possible to get the members to the place of meeting on Monday, but it has been shown that there is no difficulty of that kind. If, then, the Car Builders should meet on Monday morning, they could have Monday, Tuesday and Wednesday. The Master Mechanics could then have Thursday, Friday and Saturday. It would make little practical difference whether different sets of officers presided over the meetings of the two associations, or whether the same presided over both. The important end would be accomplished of holding the two meetings in one week, the actual consolidation being largely a formality only.

The place of holding the next conventions excited the usual interest. The Far West is holding out inducements to go to Manitou, the attractions of which are painted in glowing colors. The Rocky Mountains, soda springs and grizzly bears are mixed up in enticing confusion, so that probably in 1895 these associations will meet nearer to the setting sun than ever before.

NEW PUBLICATIONS.

Maximum Stresses in Drawbridges Having two Equal Arms. By Malverd A. Howe, C E., Professor of Civil Engineering in Rose Polytechnic Institute. Terre Haute: Moore & Langen, 1894. 12mo, paper, 17 pages, 15 cuts and one plate.

This little pamphlet gives the well known formulas for reactions, moments and shears, due to a single load on either arm of a drawbridge, with several useful tables for abridging computations. The position of the rolling load which produces maximum stress for each section is stated, and methods of graphical analysis are briefly indicated. The things which are not given are numerous, and among these are: demonstra-

tions of the formulas, explanations of the theory of the methods, a numerical example of stresses, the case of the tipper draw, and that of a draw continuous over two supports at the middle pier. The formulas for the single case investigated are not complex, but they can be simplified and the tables also be abridged by measuring the ordinate in the right-hand span from the abutment instead of from the pier; if this be done the last table on page 17 is unnecessary, as all its values are identical, but in reverse order with those of the table on page 15. The rule of thumb method set forth in the pamphlet is often an excellent one, but it cannot be trusted in computing drawbridges, where, if anywhere in bridge work, theory is indispensable.

TRADE CATALOGUES.

Clayton Air Compressors and Air Receivers. The Clayton Air Compressor Works, whose office is in the Havemeyer Building, New York, have issued an eight-page, 8 × 11 in. circular, in which they illustrate and describe their air compressors of different types and air governors and receivers. As so many appliances in which compressed air is the operative power, this circular is timely and will interest many persons.

Beaman and Smith's Catalogue B. 34 pp. 3½ × 5½ in. The specialty of this firm, which is located in Providence, R. I., is the manufacture of milling, drilling and boring machines and engine lathes. Seven milling machines are illustrated by very good engravings, but which have hardly had justice done to them in the printing. Six different styles of drilling and boring machines are also illustrated and several patterns of lathes. Short descriptions of the different machines are given opposite to the engravings. The machines seem to be well designed, and their merits are fully described in this catalogue.

The New Era Gas and Gasoline Engines. 8 pp. 6 × 3½ in. This is a little booklet in which the advantages of gas and gasoline engines are set forth. There are no engravings excepting an outside perspective view of one of the engines on the outside cover. It is a curious fact that although very few people understand the construction or operation of gas engines, the manufacturers seldom describe either in their circulars or catalogues. It would certainly add to their interest if good sectional views of the engines were given with a clear description of the principles and methods of their operation. The publication before us was issued by the New Era Iron Works, of Dayton, O.

The Marsh Steam Pump. By the Battle Creek Machinery Company, Battle Creek, Mich. 32 pp. 5½ × 7½ in. One of the marked characteristics of trade catalogues which have been received recently is their lucidity. Manufacturers do not now confine the contents of their publications to commendation of the articles they manufacture, but they explain very fully their construction, operation and other characteristics. The volume before us is an illustration of this. The pump which they make is shown by very good perspective and its construction by sectional views with full explanations of its principal features. Diagrams are also given showing its application to the heating of buildings, to dryers in paper or pulp mills, to dry kilns, to refineries and plantation sugar houses, to vacuum and multiple effect evaporators and to the handling of fuel oil.

The Aerodromic System of Transportation. In the May number of the American Engineer and Railroad Journal a notice was published of a pamphlet describing this "system of transportation." The notice was written at a time when we were sorely irritated by a number of exasperating aeronautical cranks, and it ended with a somewhat caustic reference to inventors of schemes of the character of the one described in the pamphlet referred to. One of the authors of the system referred to has written complaining that our criticism was unfair and discourteous in so far as it was personal and referred to the inventors and not to the invention. There are good grounds for this complaint, and therefore we desire to express our regret at having hastily and in a moment of irritation written what we had no right to say, and criticised the personality of the inventors, which was not fairly a subject for such criticism. The inventors we think are wasting their time and their own money—or that of other parties—in developing a scheme which seems to us to be totally impracticable, and we will be quite willing to submit to the decision of the final result of experiment with their invention to determine whether our reasoning or theirs is "logical."

Weston Engines. By the Weston Engine Company, Painted Post, N. Y. 35 pp. 6½ × 9½ in. This company has issued one of the most complete catalogues that has recently been brought to our notice, in which is the Weston automatic engine, which is built by this company. The engravings are by Bartlett, and are therefore in the very best style of the art of wood engraving. Two perspective views are given, one showing their engine with and the other without the sub-base. There is also an end view, and—what is unusual in such publications—a plan view with the cylinder shown in section. Longitudinal and transverse sections of the cylinder and steam-chest showing the construction of the valve, a perspective view of the latter, a section of the piston-rod stuffing-box, an elevation of the governor and a perspective view of the crank-shaft, cross-head, connecting-rod, a section of the stub end and a transverse sectional view drawn through the crank shaft. Accompanying these engravings are admirable descriptions of the engines and their parts, and the book winds up with an excellent explanation of that never-ending question how to calculate the H.P. of an engine. The book is a model of its kind, and if the engines the company builds are as good as their description of them they can be highly recommended.

Simple and Compound Harrisburg Ide and Ideal Engines. By the Harrisburg Foundry & Machine Works, Harrisburg, Pa. 16 pp. 3½ × 6 in. Having exhausted our superlatives in the preceding notice, we feel like saying *ditto* to the little book now before us. In this the engines built by this company are illustrated by half-tone engravings showing perspective views of the "Ide and Ideal automatic engines" and "Ideal tandem compound engine," and three views of "Ideal" engines connected direct to dynamos. There are also views of an "Ide" and a compound engine connected in the same way. The principal dimensions are given opposite these engravings, but there is no other description. The printing, engraving and general "get-up" of this book are all excellent.

CONVENTION OF THE AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

The twenty-seventh annual convention of the American Railway Master Mechanics' Association held its first session in Convention Hall, at Saratoga, N. Y., on the morning of June 18. Conside able disappointment was manifested from the fact that Mr. Chauncey M. Depew had been announced to open the meeting, but a telegram was received late the evening before stating that he was confined to his house by a severe cold. The opening address was delivered by Judge Lester, of Saratoga, and was followed by President Hickey with the annual president's address.

Referring to prospective savings in the expense of locomotive operation and the methods of obtaining them, Mr. Hickey alluded to a compound locomotive that was engaged in ordinary freight traffic running in with simple engines and showing a net gain in fuel over the average number of simple engines of not less than 18 per cent., and that this record was obtained in the face of the fact that the enginemen, as a rule, do not possess the friendliest feelings toward engines of this type. During the time a close record was kept of the cost of repairs, and while it was a fraction greater than the average of the simple engines, it was a matter of insignificance as compared with a saving in fuel. He also expressed the opinion that the weight of experience is certainly favorable to the introduction of compound for all ordinary work provided the boiler is in size and capacity suitable to the engine requirements. He then dealt in an improved method of shop tools and method of handling locomotive repairs and other items of interest to the convention.

The Secretary's report showed that there are now on the roll 515 active members, 15 associate members and 18 honorary members. The Treasurer's balance showed $361.71.

The first report presented was that on the Cracking of Back Tube Sheets. The committee stated that there was an overwhelming and well-nigh universal testimony on the part of the members that radial stay boilers, carrying high pressure, are more liable to crack than other types, and that the causes of this are twofold. First, and preliminary, that cracking is due to too rigid staying of the crown sheet adjacent to the flue sheet and flange thereof; and, second, by placing flue holes too close to flanges, and possibly some of the difficulty is chargeable to the high steam pressures carried. The report was accompanied by a large number of engravings showing the methods of staying crown sheets. The report will be valuable in this respect that the dimensions are very fully given on all the drawings, but there is nothing particularly novel shown in any of the designs presented. In the discus-

sion following the reading of this report there was the usual variation of opinion in regard to the relative merits of the radial and crown bar method of staying.

The report contains an extract from a paper read by Mr. Yarrow, in which he said that there had been considerable difficulty from leaking tubes in certain locomotive boilers built for torpedo boats by his firm some time ago. The difficulty had been entirely overcome by staying the front end of the crown sheet with stays passing through a stuffing box and having a nut on the outside. Exception was taken to this method of staying from the fact that if the crown sheet expanded and was up there would be nothing to hold it until expansion was equal or the contraction had brought the nut down to a bearing at the top. There was, however, a general consensus of opinion that a too rigid staying at the front end of the fire-box was apt to result in leaking tubes. Others attributed the cause to the fact that tubes were continually rolled out, and repeated contractions and expansions caused them to wear in the tube sheet and caused the leakages. A number of gentlemen considered that a flat crown sheet was less likely to leak than others, but the testimony was so contradictory in regard to the relative merits of crown bar and radial stay that it would be difficult for an unprejudiced and uninformed person to judge between the merits of the two. In regard to the difference in expansion between the inside and outside sheets of a fire-box we would call attention to a paper printed in the American Engineer and Railroad Journal for March of this year, showing the experiments which were undertaken by the Western Railway Company of France, to determine the difference which there is in the expansion of the inside and the outside sheets of fire-boxes. These measurements were very carefully made, and it was shown that while the inside sheet expanded more rapidly than the outside sheet while pressure was being raised, that when the boiler finally reached its working pressure the expansion of the two sheets was practically the same and the crown bars rested on the brackets bolted to the outside sheet. It might, therefore, be argued, as the result of these experiments, that the strains on the stay bolts come while steam is being generated, and not while the boiler is actually held at its working pressure. This, however, would be a matter for future investigation, and we would recommend it to the members of the Association for their careful attention in the future.

The Committee on Oiling Devices for Long Runs reported that they have received a great deal of interesting information both from the locomotive superintendents of Great Britain and this country. The practice of the English superintendents may be broadly characterized as using oil reservoirs of a high level that can, if necessary, be filled while the engine is running. They are of brass, square in plan with hinged top lid, and internally divided into sections corresponding with the number of holes, small tail pipes leading from them. In the case of axle boxes usually one to each journal and one to each jaw face. Worsted syphon trimming is common, as well as horizontal plugs for each pipe, so that the oil may not be wasted when the engine is standing between trips. In the American Engineer and Railroad Journal for November, 1893, a description of the Corey lubricator was published. Mr. L. B. Paxson, of the Philadelphia & Reading Railroad, was the only one that advised the committee of any practical acquaintance with this device. He says that it has been in use for one year on a compound engine, and showed a saving of about 25 per cent. over the old way of oiling.

Other devices for oiling while running are reported by Mr. Stevens, of the Lake Shore & Michigan Southern Road. He supplied oil pipes from the footboard to all axle journals on locomotives drawing the Exposition Flyer, which had a continuous run of 135 miles, with the result that the entire service of these trains was performed without a single hot box. Other devices of a similar kind were reported by various members

For cylinders, slide valves and air pumps some form of lubrication by condensation displacement feed is every-day practice; but in Great Britain it is common to use in addition Furness lubricators—one for each cylinder—that come into operation only when engine is running with steam shut off. Mr. I. Holden (G. E.) remarks that the Vacuum Coy's sight feed has been superseding the Roscoe, because the latter did not readily displace the heavier and thicker oils, but that the Vacuum has the defect of increasing the feed almost double when the steam is shut off. He has tried the De Limon's double-acting sight feed, and this has such large capacity, works so economically and regularly with throttle open or shut—and with all densities of oil—that he is trying a dozen of them, the first cost of one of De Limon's being less than the combined cost of one Vacuum and two Furness, and there being a saving of two pints of oil in a run of 243 miles as compared with the use of one Roscoe and two Furness lubricators.

The only special point in the few replies mentioning tender oiling is the use of spring pads or cotton-seed hulls to continuously lubricate the under side of journals.

To briefly summarize, the replies and drawings show that modern practice for high-speed lubrication is an endeavor to deliver a small amount of oil continuously over the whole length of bearing surface. Bearing surfaces are much larger (we have yet to hear of an engine with too much wearing surface at any point). It is not judicious to trust to one oil-hole where two are possible. Cups or oil-pockets are solid (cavities in the metal) rather than separate. Grooves are liberal in number and size. The cheapest of oil is then admissible. Strainers and covers over all oil pockets are desirable.

The report was followed by an appendix of oils and oil tests, which we reprint in full.

OILS AND OIL TESTS.

The replies show that the use of Galena or other mineral oil, graduated so as to be as limpid in winter as in summer, is common American practice, whereas in Great Britain there is a marked inclination to the use of vegetable oils.

Thus Mr. Bellington uses a mixture of 33 per cent. rape to 66 per cent. of mineral oil, and in hot weather makes the proportion 50 per cent. of each. Mr. Webbe did use 90 per cent. rape and 10 per cent. mineral, but now uses 50 per cent. of each for cylinders and machinery. Mr. Johnson uses the 50 per cent. proportions, but for machinery a thinner mineral oil is used in making the mixture. Mr. Hanson (G. & S. W.) uses vacuum (mineral) oil for cylinders and rape or olive for machinery, making no difference in cold weather; and Mr. Cambie uses colza for machinery, except in very hot weather, when castor oil is used.

Mr. Ivatt uses olive for machinery and black mineral for cylinders, making no difference to suit the season, as extremes of temperature are not severe. He averages 23 pints per 1,000 miles on fast trains, and from 20 to 22 on slow freights and branch trains.

Mr. Holden's tests for oils (presumably mineral) are:

	Specific Gravity.	Flashing Point.	Viscosity.	Congealing. Point.
Machinery......	.917	375°	2.2 at 180°	28°
Cylinders.......	.897	550°	.28 at 140°	36°

Mr. Adams' specification for cylinder oil is:

The cylinder oil should have a flashing point of not less than 500° F., open test, with a viscosity of twice that of rape of 212° F.; the specific gravity and burning point of oils will be taken into account when testing.

Specification of machinery oil. The engine oil should have a flashing point of not less than 375° F., with a viscosity of twice that of rape at 100° F., and should not oxidize or become gummy when exposed to the atmosphere. The specific gravity will be taken into account when testing.

Mr. Dean's specification is as follows:

The flashing point to be determined in each case by the Board of Trade close test.

The viscosity to be tested by Sacker's viscometer (water at 60° F. = 1).

No. 1. Petroleum for burning. A declaration is to be made on every invoice and signed by a principal of the firm in the following words: "We guarantee that the oil is well refined, and that it will not give off inflammable vapor at a lower temperature than 85° F. by the Board of Trade close test. We also guarantee that the color of the oil is 'water white,' and that the specific gravity at 60° F. is not less than 0.8 nor more than 0.805."

No. 2. Oil for gas-making. To be of suitable quality for the manufacture of gas for carriage lighting. Flashing point, 200° F. Specific gravity at 60° F., 0.84.

No. 3. Oil for cleaning. To be clear, and to give neutral reaction. Flashing point, 250° to 290° F. Specific gravity at 60° F., 0.865. Viscosity at 60° F. not more than 4.0; at 140° F. not less than 2.0.

No. 4. Oil for electric light. To be clear, and to give neutral reaction. Flashing point not less than 315° F. Congealing point not above 22° F. Viscosity at 60° F., not more than 20; at 140° F., not less than 4.

No. 5. Oil for carriage lubrication. To be pure pale mineral oil and to give neutral reaction. Flashing point not less than 330° F. Congealing point below 22° F. Specific gravity at 60° F., 0 905 to 0.915. Viscosity at 60° F., not more than 30; at 140° F., not more than 4 5.

No 6. Oil for heavy machinery. To be refined and freed from light oils, but not distilled. Flashing point not less than 220° F. Congealing point blow 20° F. Specific gravity at 60° F., 0.88. Viscosity at 60° F., not to exceed 56; at 140° F., not less than 5.

No. 7. Oil for cylinders, etc. To be pure undistilled dark mineral oil of the best quality, refined and free from light oils. Flashing point not less than 480° F. Congealing point below 20° F. Specific gravity at 60° F., 0.90. Viscosity at 140° F., not to exceed 40; at 180° F., not less than 15.

And he adds, a good lubricant for the machinery is rape, 85 per cent., and mineral, 15 per cent.

Mr. Soule's specification reads thus:

Passenger engine oil. When shipment is received a sample will be taken at random from any barrel, and the material accepted or rejected on the result of this examination. The right to test any and all barrels will be reserved. Freight both ways will invariably be paid by the shipper in case of rejection.

Passenger engine oil will not be accepted which

1. Flashes below 300° F.
2. Burns below 400° F.
3. Shows a tarry deposit when 5 cubic centimeters are mixed with 95 cubic centimeters of 88° B gasoline and allowed to stand one hour.
4. Is not free from dirt, specks, lumps, grit, water, soap, or suspended matter of any kind.
5. Contains less than 20 per cent of acidless animal oil (tallow or tallow oil preferred). Shipments containing more than 30 per cent. of tallow or tallow oil are not desired, and no increased price will be paid for them on this account.
6. Contains more than 1 per cent. of free acid.
7. Shows a cold test higher than 5° F. between October 1 and April 1.
8. Has a gravity below 26° Beaumé, or above 31° Beaumé.
9. Contains a notable percentage of paraffine wax.

Owing to the fact that some of the members were to leave in the afternoon of Tuesday, the report on the specifications for boiler steel was the next one presented. It was stated that there was a very decided difference as to the quality of fire-box steel, some of the members favoring a soft steel with ultimate strength ranging from 50,000 lbs. to 58,000 lbs., while the majority preferred a harder quality with an ultimate strength of 55,000 lbs. to 65,000 lbs., and in each case there was a difference in the chemistry.

The specifications presented for discussion are shown below:

FIRE-BOX STEEL. CHEMICAL COMPOSITION OF.

	Number 1.		Number 2.		Number 3.	
	Desired not over	Will reject over	Desired	Will reject over	Desired	Will reject
Phosphorus	0.02	0.06	......	.03	.03	.04
Sulphur ...	0.02	0.045	......	.03	.02	.05
Manganese.	0.5	0.50	......	.35	.04	.55
Silicon.....	0.02	0.035	......	.03	.02	.04
Copper.....	....	.....	......	.04	.03	.05
Carbon ...	....	.....	Low as possible.		.18	l's t'n .15 over .25
Tensile ...	....	50,000	......	50,000	....	55,000
Strength ...	....	58,000	......	60,000	....	65,000
Elongation.	....	......	......	......	....	......

Dr. C. B. Dudley, Chemist of the Pennsylvania Railroad, was called in for consultation, and gave his reasons for reducing the metalloids to the lowest possible limit. Taking phosphorus for an example, he stated that it was possible to reduce it to .02, but some of the sheets giving the highest mileage had phosphorus as high as .07. It therefore appeared unwise to insist upon the lowest possible limit when no compensating gain was apparent. As regards sulphur, this is largely a matter of fuel, the lower limits being possible where natural gas is used. As this would discriminate in favor of localities using natural gas, the limit was placed at .05 as a maximum, with .02 desired.

While manganese and carbon have both a hardening effect, it is the opinion of the committee that the hardening should be accomplished by carbon rather than by the other ingredient. Silicon is believed to have the effect of insuring solidity in ingots, although not much is known as to the condition in which it exists. Mr. Dudley advised a moderate specification giving steel makers wide limits as were consistent with the quality of the steel desired.

The committee endeavored to get positive information concerning the performance of hard and soft fire-box sheets. It had the tensile strength taken from the sheets both before and after service, from which latter analyses were made. The tensile strength varies from 77,000 lbs. down to a little over 50,000 lbs., while the mileages vary from a little under 500,000 to a little over 50,000 miles. The results of examination were quite conflicting; but when it is remembered that the treatment of the fire-boxes on the road has probably more effect upon the life than has the original quality, it was what might have been expected. It was soon seen that both hard and soft steel might be found in both the long and the short-lived boxes, and sometimes in the same box.

The weight of evidence, however, was toward steel in the neighborhood of 60,000 lbs. tensile strength giving the best results.

For several reasons the harder steel has decided advantages, namely, in better holding threads and less bagging between stay bolts. Where bagging occurs the tendency is for the holes to open on the water side and thus lessen the hold upon the bolt.

The reason for recommending a test piece of parallel section in preference to the shouldered section usually prepared is that the first-mentioned forms show a higher elongation and one which we believe represents more truly the real elongation of the sheet than does the shouldered form in which the wide ends appear to brace or stiffen the adjacent parallel section for some distance.

This point was clearly demonstrated in a series of tests in which sheets were cut up into test pieces, alternate ones being prepared to the different sections mentioned. It was found that in specimens not less than 8 in. long in tested section there was little difference in the tensile strength, but the elongation in straight pieces was markedly less than that of the other forms which gave practically similar results.

The reasons for choosing dimensions of coupon, namely, 36 in. × 2 in. in rough, of which a section of at least 8 in. between grips is to be prepared 1½ in. wide, were that such length of coupon will make two test specimens if check testing is desired, or it will furnish one tensile test specimen and one for bending and quenching tests. A specimen finished 1½ in. wide and of the thickest sheets used in locomotive boilers will be within capacity of a 100,000-lbs. test machine, and a 50,000-lbs. machine will serve for nearly all that are used. Your committee was satisfied itself by tests that specimens 1½ in. wide prepared from coupons 2 in. wide and of thickness of ½ in. do not appear to be affected by shear hardening.

The results were as below:

TEST OF ½" BOILER STEEL SHEARED TO DIFFERENT WIDTHS AND PREPARED TO SECTION 1½" WIDE.

No.	Rough Width.	Finished Width.	Tensile Strength.	Elongation in 8".
1................	1¼"	1.522"	56,900	24
2................	2"	1.522"	56,400	26
3.	2¼"	1.522"	56,300	29
4................	2½"	1.522"	56,100	26.5

The heating and quenching test is introduced because many users of steel have no other available method of investigating the quality of steel used, and it is to be noted that in nearly all marine boiler specifications this clause is embodied with modifications.

In order to establish the identity of the test specimen, the method requiring the sheet and the test piece to be attached is preferred.

It will at times happen that the test coupon is too much warped to be prepared without some straightening. In such cases it is necessary that the manipulation shall not cause hardening of the piece. In such case we recommend squeezing cold in press or between anvil and tup of steam hammer; but it should never be done by hammering, nor should the coupon be subject to any heat treatment before testing.

No better method has been proposed of detecting lack of homogeneity in fire sheets, than that of nicking test piece on edges and bending. Laminations are thus shown when careful examination of edges does not reveal them.

SPECIFICATION.

General Requirements.—Under head of ordering, inspecting at mill, marking and shipping, no recommendations are made, for reasons that no general rule suitable for all roads can be formulated, and it is not essential for uniformity that such rule be made.

Test Pieces.—Test pieces, one from each plate, shall be in rough, 2 in. wide and 36 in long, and as nearly straight and free from twist as possible and in no case must be annealed. Each plate shall bear maker's name, either rolled or stamped. The heat number, and in addition such identification marks as may be specified by ordering road, shall be put on each plate and test piece.

When inspectors are present at mills, butt strips may be cut

from any plate, provided such sheets are represented by test coupons. Where inspectors are not at mills, they must, as far as possible, be cut from a single sheet as rolled, and each sheet cut into butt strips will be represented by a test strip. All butt strips as well as test strips shall bear the heat number.

Shear Marks.—Each sheet shall be accompanied by test coupon 2 in. × 36 in. long attached at one end to sheet. To facilitate future matching, should it be necessary, both sheet and coupon shall be stamped twice across division line with a shear mark, either round, oval or of other agreed form; which mark should be not less than 3 in. across.

In cases where one large plate is cut into several smaller ones, all represented by one test piece, the same shear mark shall be stamped across each division line in two places before shearing, so that subsequent identification may be readily performed.

Dimensions.—Plates must be of shape and dimensions ordered. Any excess in weight over that corresponding to the dimensions in the order greater than that specified in table below will not be paid for.

In computing weight of plate from dimensions, 1 cub. in. will be taken as weighing 0.2836 lb.

Allowance for overweight over that corresponding to dimensions.

For plates	$\frac{1}{4}$ in.	thick,	10	per cent.
"	$\frac{5}{16}$	"	8	"
"	$\frac{3}{8}$	"	7	"
"	$\frac{7}{16}$	"	6	"
"	$\frac{1}{2}$	"	5	"
"	$\frac{9}{16}$	"	4½	"
"	$\frac{5}{8}$	"	4	"

Plates measuring one-one hundredth of an inch less in thinnest part than that ordered, and all plates which show seams or cracks at the sheared edges, or which have cracks, slivers, or depressions in the surface, or which develop defects in working, will be rejected. Rejection on account of thinness is to be made only after measurement of the actual sheet. Test pieces being prepared from the edge of sheet are liable to be thinner than the main sheet.

Test pieces when finished will be 1½ in. wide in test section and of full thickness of plate, and may be either parallel sided or of reduced section, and prepared either by longitudinal planing or milling. Where reduced section is adopted, the distance between bottom of fillets shall be not less than 9 in., and radius of fillets shall be not less than ½ in. and preferably more. Elongation will be measured between tram punch marks originally 8 in. apart, and on reduced sections placed approximately equidistant between fillets. In parallel-sided sections the tram punch may be applied at more than one point to insure breakage occurring between the marks.

Special Requirements for Shell Steel.—Tensile strength, 55,000 lbs. to 65,000 lbs. Elongation not less than 20 per cent. in 8 in. Test piece having rough edges removed by filing, grinding or machining, shall, without annealing, bend over on itself both while cold and after being heated to a cherry red, and dipped in water at 80° F. without showing cracks or flaws on outside edge. No chemical requirements.

Special Requirements for Fire-Box Steel.—The majority of the committee favored specification reading as follows:

Metal is to have tensile strength of 55,000 lbs. to 65,000 lbs. with 60,000 lbs. desired and 28 per cent. elongation preferred.

The chemistry desired is: Carbon, .18; phosphorus, not above .03; manganese, not above .40; sulphur, not above .02; silicon, not above .02.

Plates will be rejected having: 1. Tensile strength less than 55,000 lbs. 2. Tensile strength over 65,000 lbs. 3. Elongation less than 22 per cent. in 8 in., and in ¼ in. plates not less than 20 per cent. in 8 in. 4. Failure to stand bending and quenching test as for shell steel. 5. Any seam or cavity more than ¼ in. long in any of the fracture of homogeneity test.

Chemical.—Carbon, over 0.25; carbon, below 0.15; phosphorus, over 0.035; manganese, over 0.45; silicon, over 0.03; sulphur, over 0.045.

Homogeneity test is made in the following manner:

A portion of the broken test piece is nicked with chisel on opposite sides alternately, nicks being about 1 in. apart. Test piece is then firmly held in vise and broken by a number of light blows, bending being away from the nicks.

Laminations more than ¼ in. long to condemn.

The object of this is to open and reveal seams due to failure to weld up, or to foreign interposed matter or cavities due to bubbles in the ingots.

The above specification is intended to be liberal in its provisions, and does not differ greatly from others that have been used, and committee believes that it will be satisfactory.

This report was signed by Messrs. A. W. Gibbs, William Forsythe, T. A. Lawes, G. R. Henderson and E. M. Roberts, while Messrs. Henderson and Roberts united in submitting the following minority report:

We agree to all the items of this proposed specification except the tensile limits of fire-box steel.

Believing that this material should be kept soft, and that a hard steel is objectionable on account of its liability to crack in service, we recommend that the minimum ultimate strength be 50,000 lbs. and the maximum ultimate strength 58,000 lbs. per square inch. Some of the members of the committee urged the plea that as the working pressure of boilers had been increased from 30 to 50 per cent. over previous pressures, and as it was unwise to thicken the fire-box sheets, that a stronger material should be used. We, however, think that an increase of strength in the steel of 10 per cent. will go but a very short way toward making up the increase in pressure of 30 or 50 per cent., especially when the risk of cracked sheets and use of a harder steel are the penalties.

We, therefore, propose to the Association that the tensile limits of fire-box steel in the new specification be altered to read from 50,000 to 58,000 lbs. per square inch respectively, and that the carbon be reduced to from 0.10 to 0.20 per cent., the elongation being 20 per cent. for ¼ in. plates and 24 per cent. for $\frac{5}{16}$-in. thick and upward in 8 in. of length.

After some discussion an amendment was introduced changing the condemning point of sulphur from .045 to .035, and with this amendment the report was adopted as the practice of the Association. During this discussion Mr. McConnell said:

"We have used in the last year in the neighborhood of 600,000 lbs. of boiler steel. We have a record extending over some ten years, and the average life of the fire boxes does not exceed with us five years. In some cases the fire boxes have been worn out in two years. Our specification has been heretofore from 60,000 to 65,000 lbs., but we believe that is too high. I do not think the same specifications for steel will answer equally well in bad water and good water. We have reduced the tensile strength of steel down to from 50,000 to 57,000 lbs., and the carbon down to not less than .13 nor above .18. We think we get better results there. The character of the water has a good deal to do with the hardness of the steel that you can use. Our water is largely an alkaline water. We have a chemist; and of every sheet of steel that comes to us we make a chemical analysis as well as a mechanical test. The largest sheets we use are 235 in. long, 109 in. wide and $\frac{5}{16}$ in. thick. That is used with the side sheet and wagon top. The sheet on some of the boilers is 114 in. wide by 186 to 196 in. long. I think it would be a mistake to have any general recommendation for steel for fire boxes for the whole country."

In reply to a question from Mr. Dean as to the reason why the committee has ignored the elastic limit of steel, Mr. Gibbs replied that, in the first place, we use very little of it; and secondly, all of the strain is somewhere near 14,000 lbs. per square inch, and that strain is so much below the elastic limit of any steel we know of that we did not consider it necessary to touch upon it. The determination of the elastic limit is a much more troublesome matter than that of the other qualities; it is necessary to put micrometers on the piece and measure each pull and the stretch, and go on that way until the stretch begins to increase faster than the strain. There is a good deal more work in it than the ordinary test. As to making the test longitudinally and crosswise, we found only one specification where that was referred to. In that case there was no difference in the tensile strength of the sheet either way. They called for an elongation of 25 per cent. pulled lengthwise, and 25 per cent. pulled crosswise. We made a little test and got about the same result—2 per cent. difference. On the matter referred to by Mr. McConnell—the tensile strength—of course we haven't got any water east of the Mississippi River that is as bad as the water he uses. We tabulated the results of 255 boxes, and got as many as possible of the fire boxes west of the mountains, where they run in a limestone country, and as far as we have gone there is nothing to show anything inconsistent with the highest return in sheets having the highest tensile strength.

Some exception was taken to this reason on the ground that the factor of safety should be based on the elastic limit.

Mr. Fox, of Leeds, England, was cited as having declared that there is no trouble in getting phosphorus and sulphur as low as .04 and .05, and this in spite of the fact that there is no natural gas to be used as fuel in that country. A case was given of a boiler that had exploded wherein the steel could be bent nearly double lengthwise of the grain, while across the same it could only be bent to an angle of about 5°

Mr. George Gibbs stated that he had a tabulated statement according to the makes of steel and the tensile strength. The average mileage is 260,000 miles for fire-box sheets. The tensile strength varies between 50,000 and 60,000 lbs.

Opinions were expressed against annealing of the sheets, on the ground that there is a great deal of difference in annealing, and the man who makes the sheet has no means of knowing what it will be subjected to if it is to be put through an annealing process. Mr. Leeds, of the Louisville & Nashville Railroad, called attention to one of the items in the specifications of his road where, if the elongation exceeded 30 per cent the tensile strength was to be increased 5,000 lbs., adding that they had obtained very good results with fire-box steel ranging in strength from 52,000 to 58,000 lbs., and that they insisted as much as possible on the elimination of every element that could act as a hardener.

At the conclusion of this discussion there was a sort of an experience meeting, wherein the topic was that of the compound locomotive. The talk was opened by Mr. Garstang, who stated that there was a compound locomotive on his road, made by the Richmond Locomotive Works, and which is illustrated and described in another column of this paper. He practically corroborated what we published in our April issue as to the saving effected by the machine. He was followed by Mr. Vauclain, of the Baldwin Locomotive Works, who cited one of their engines that is now hauling a fast express between Camden and Atlantic City, and which is scheduled for faster time than the Empire State Express, and concluded by advocating the building of boilers that would carry 200 lbs. pressure of steam.

Mr. Forney then submitted the following statement and letter, which we publish in full, and which are self-explanatory :

STATEMENT.

Relative to Mileage, Speed and Fuel Consumption of New York Central Railroad Engines Number 999, Empire State 888, and the London & North Western Compound Engines "Greater Britain."

	London and North Western Engine "Greater Britain."	New York Central Engine No. 888.	New York Central Engine No. 888.	New York Central Engine No. 999.
	T.* Cwt.	T.* Cwt.	T.* Cwt.	T.* Cwt.
Weight of engine and tender in working order	77 2	89 6	89 6	91 0
Average weight of train, including passengers, baggage and mails, but excluding engine and tender	160 8	162 14	180 12	279 0
Average weight of train, including passengers, baggage and mails, and including engine and tender	237 10	252 0	269 18	370 0
Time table time, deducting stops	76 h. 7 m.	34 h. 0 m.	76 h. 8 m.	28 h. 20 m.
Deduct time made up by engine	0 50	....	0 h. 53 m.	....
Actual running time	75 h. 17 m.	34 h. 0 m	75 h. 15 m.	28 h. 20 m.
Total distance traveled attached to trains	3,588 miles.	1,776 miles.	3,848 miles.	1,287 miles.
" " " light	24 "	....	26 "	45 "
	3,612 miles.	1,776 miles.	3,876 "	1,332 "
Average speed	47.66 miles per hour.	52.24 miles per hour.	51.13 miles per hour.	45.42 miles per hour.
Total weight of coal consumed, excluding lighting up	47 tons 17 cwt.	26 tons 11 cwt.	56 tons 9 cwt.	21 tons 17 cwt.
Actual consumption of coal per mile excluding lighting up	29.87 lbs.	33 48 lbs.	32 86 lbs.	38.3 lbs.
Consumption of coal per mile, including 1.2 lbs. for lighting up	31.07 "	34.69 "	35 " †	39.21 "
Total number of ton miles, including passengers, baggage and mails, but excluding engine and tender	575,537	288,822	695,008	359,073
Total number of ton miles, including passengers, baggage and mails, and including engine and tender	852,224	447,552	1,038,619	476,190
Consumption of coal per mile per ton of train, including passengers, baggage and mails, but excluding engine and tender, at 29 87 lbs. per mile	2.979 ozs.	3.30 ozs.	2.960 ozs.	2.18 ozs.
Consumption of coal per mile per ton of train, including passengers, baggage and mails, and including engine and tender, at 29.87 lbs. per mile	2.012 "	2.12 "	1.936 "	1.644 "

* 2,240 lbs.

† On the test of 888 the consumption of 35 lbs. per mile includes the coal used for kindling at the commencement of test, and the amount used each night to maintain the fire while the engine was in the round house.

New York, June 13, 1894.

Mr. M. N. Forney, Hotel Windsor, Saratoga, N. Y.:

Dear Sir: When at the World's Fair I picked up one of the London & Northwestern folders, giving weight, speed and fuel consumption of the *Greater Britain*, which they claim is a sister engine to the *Queen Empress*.

I have been making some tests in regard to fuel, comparing them with the *Greater Britain*; in the first test with engine No. 888, on the Empire State Express, I was somewhat surprised at the low consumption of fuel of the simple engine, and also made another test with engine No. 999, on the same train, and was still more surprised on comparing it with the compound *Greater Britain*. I then made another test with engine No 888 on the same train, running about the same number of miles as the compound. I inclose herewith the results of the last test compared with the *Greater Britain*, which I think is a favorable showing; as you will see, we ran more miles and at a higher rate of speed than the compound. I was particular in getting the total number of passengers carried on the train, also the amount of baggage and the weight of same from the transportation department—this not including the satchels, etc., carried by the passengers in the cars. I am of the opinion that this will be interesting to you, as you will note the amount of coal is included for lighting and also for maintaining fire when engine was not in service between trips. I inclose herewith a London & Northwestern folder.

Yours truly,
William Buchanan.

The question was at once raised as to the relative grades on the two roads whose engines are thus compared, and it was stated that they are much the same. It was added that the London & Northwestern use a great deal of Welsh smokeless coal. It is a kind of anthracite and a slower burning coal than that used on the New York Central, but with practically the same evaporative value. Attention was, however, at once called to the fact that Mr. Webb reports that he has obtained an evaporation of 10 lbs. of water per pound of coal, whereas it is about impossible for us to get more than 6¼ lbs. in this country. If, then, we make the correction based on these figures, it leaves the Webb engines still further behind than is shown in this report.

One of the advocates of the compound engine stated that it was very essential that these locomotives should be kept in the best possible state of repair, as "the little leaks and things we sometimes have will tell less with the simple engine than with the compound." Then other speakers followed with a mass of figures that in a general way tended to prove that there was a decided saving in fuel as the result of the use of the compound locomotive, and this saving ranged from 15 to 40 per cent. with about the same cost for repairs.

Mr. Medway submitted a statement of his experience with the compound engine for six months ending September, 1893 : Compound cylinders, 21 31 × 26 ; simple cylinder, 18 × 24 ; steam pressure, compound, 180 ; simple, 180 ; miles run, compound, 12,794 ; simple, 19,366 ; miles per ton of coal, compound, 25.1 ; simple, 22 ; repairs, cost per mile in cents, compound, $2.75 ; simple, $1.26.

Mr. Mitchell : "We used compound engines with the object of reducing the consumption of water ; and by using them we thought we could escape two water tanks and obtain better water at another point, and prolong the life of the flues 40 per cent. and the life of the fire box thirty per cent. We have run them in fast freight service. The result shows a saving in coal, no greater repairs and the engineers prefer them to the simple engines. Two of these engines with 68-in. wheels were put in the passenger service, and when first received the consumption of coal was greater than on the simple engine. I took active steps to draft the engines properly, and now they are burning less coal than the simple engines and give good results. I can fully indorse the Baldwin compound engine as a more economical engine than the simple engine. We now have fifteen compound engines on our line, six of which are decapods."

The discussion was closed by Mr. Dean, who remarked that perhaps one of the reasons for the better showing of the New York Central engine as compared with Mr. Webb's engine was

that the former had about 2,000 sq. ft. of heating surface, while the latter had but 1,350.

The next report read was that on Locomotive Fire Kindlers; the conditions laid down for the successful kindler were:

1. There must be no oil stored in the building. 2. There must be no gravity flow toward a building under any circumstances. 3. Only so much oil must be brought into a building as will kindle the fire or fires needed; the surplus, if any, immediately removed. 4. A burner easy to handle. 5. No possibility of leaving the supply of oil on by accident or carelessness. 6. A system of fire kindling cheaper and better than that in use.

The report concluded with a description of the Leslie fire kindler as used in the shops of the Chicago, Rock Island & Pacific, the Burlington, Cedar Rapids & Northern, a full description of which is given in another column of this issue.

The report of the Committee on Exhaust Nozzles consisted of some very carefully tabulated statements of the results obtained in a shop test with an adjustable exhaust nozzle. The adjustment of the nozzle consisted in a partition that could be raised or lowered at the junction of the passages leading from the two cylinders. This partition had a vertical lift of 5 in., and its object was to increase or decrease the area of the exhaust pipe at the combining point. It was also arranged with a telescope pipe that had a vertical movement of 5½ in. This was to obtain, if possible, a fixed relative position between the top of the exhaust tip and the stack.

The conclusions reached, as a result of these tests, were:

1. The results show that within the limits of these experiments the vacuum is greater when the nozzle is below the center of the boiler than when above it. The extreme limits of variation of the height of the nozzle in these tests was from 1¼ in. below the center of the boiler to 11 in. above, which corresponds to a variation from 28¾ in. from the base of the stack at the top of the smoke arch to 16 in. from the same point.

2. It was found that the back-pressure line on the indicator cards was raised considerably when the partition in the exhaust pipe was at the lowest position and when the speed was low, especially for long cut-offs (see fig. 15). This is due to the interference of one exhaust jet with the other. It is evident that for passenger engines the position of the partition is immaterial, as there was no rise of the back-pressure line on the indicator cards at high speed for any position of the partition. The variation of the position of the partition from the top of the exhaust nozzle was from 28 in. to 15¾ in., and the variation of one opening of the exhaust pipe at the partition was 65 to 123 per cent. of the area of the exhaust nozzle.

3. After experimenting with 13-in., 14-in. and 16-in. straight stacks and a 13-in. tapered stack of the designs shown in figs. 4 to 7 inclusive, it would appear that the maximum draft can be obtained under all conditions by using a tapered stack having easy approach at the bottom and a tapered part at the top, having a total angle of about 10°. Fig. 14 shows the general shape of such a stack. It is important that the contracted portion of the stack and the exhaust nozzle be so located that the steam will strike the stack at or below the contracted portion.

4. With this engine a 14-in. straight stack gave a greater vacuum than a 13-in. and a 16-in.

5. It was found that a variation in the position of the choke in a straight stack, arranged as shown by fig. 8, did not materially alter the vacuum when the steam jet struck the stack below the choke. (See Table VI.) But when the exhaust nozzle was raised and the choke lowered so that the steam jet struck the stack above the choke, the vacuum was materially reduced.

6. This test shows that an increase of the length of the smoke-box over and above that necessary to get in a cinder pocket in front of the cylinder saddle is unnecessary and undesirable as the long smoke-box greatly decreases the vacuum. Sufficient area of netting can be put into a smoke-box which is long enough to give room for a cinder pocket in front of the cylinder saddle.

In the discussion which followed, Mr. McConnell, of the Union Pacific Railroad, gave some interesting information in regard to the experience on his road with the straight and diamond stacks. He said: "Our cylinders are constructed on a very liberal plan. The result of the diamond stack in dollars and cents to our company has been that in 1890 we hauled 254 loaded freight cars one mile with a ton of fuel; in 1893 we hauled 260 cars with a ton of fuel; in passenger service, 1890, 119; 1893, 145 passenger cars one mile with a ton of fuel; in 1890, 2,590 tons one mile; 1893, 2,757 tons of freight one mile with one ton of coal; in 1820 our engines were all equipped with the extension front and straight stack; in 1893, all equipped with diamond stack. In 1890, expense of handling cars, including expense of motive power and car department, was 3.17; in 1893, reduced to 2.79; 1890, the passenger service was 5 cars to a train; 1893, 5.96. The freight service has also increased: 15.86 cars in a train in 1890, 17.12 in 1893. Tonnage has increased, and we have saved in one year 87,000 lbs. of coal by our diamond stack. Our flues were worn out faster with the extension front end. Our experience has been, it is more economical and we get better results from the diamond stack than extension front end."

This statement was followed by a desultory talk on the comparative merits of the long and short front ends, and about as many opinions were expressed as there were speakers, the result of which was that the committee was continued for another year, with instructions to take up and investigate the relative merits of the straight and the diamond stacks.

The committee appointed to report on the Methods of Sanding the Track stated that the probable saving that can be effected by the use of a well-designed air apparatus would amount to from 35 to 50 per cent.

According to the reports, the cost of sand in the box varies from 20 cents to $2.47, and averages $1.13 per ton. In cases where the cost is given as low as 20 cents per ton we can hardly believe that the cost of loading and transportation have been taken into account. However, taking the average cost per ton and the average amount used by each engine, as given in the reports, and figuring a saving with improved devices of one-third, which we believe to be a conservative estimate, we have a saving in value of sand alone of $17.82 a year. Adding to this the reduced wear of tires, machinery, tender and car wheels, rails and ties, and also the lessened resistance to trains, the result is strongly in favor of this method of sanding.

The committee placed particular stress upon the necessity of having the sand thoroughly dried and screened through a netting not coarser than four meshes to the inch each way, or perforated sheet steel with openings not over ⅛ in. wide, as the current of air has a tendency in light feeding to blow out only the finer sand, the coarser material accumulating and in time requiring to be cleaned out by a stronger blast through openings provided for that purpose.

The experience of the committee on special shop tools coincides so closely with our own editorial experience as to be really identical. We have found that those things which attract the most attention are the wrinkles and home-made contrivances that are made by men to help themselves out of difficulties, and that these are the last things to be mentioned and shown when we are on a visit to shops. In dealing with this same spirit the committee writes:

"Your committee were somewhat delayed and inconvenienced by the failure of members to fully understand the exact nature of the subject to be reported upon, many thinking that we desired to get information in regard to patented and manufactured devices only, and that the many handy and useful tools gotten up in their shops were not to be included. Several members writing us that they had no tools purchased with a view of meeting special work, but had gotten up in their shops at different times many useful tools to meet certain classes of repairs on locomotives, but they did not suppose we wanted them, as they were of the opinion that all other shops had been driven by necessity to provide just such things; however, when we got it fully understood with them, we were very much pleased with the result. In this way we have succeeded in bringing out from under the work benches and back corners of tool-rooms, etc., a great many things of interest, a majority of which can be fitted up in any well-regulated shop at a nominal cost, and without having to order much, if any, new material, and certainly without having to make requisitions for new tools. Many of these devices are the result of bright mechanics and foremen being forced to accomplish much with small resources, others are the result of study on the part of mechanical engineers and draftsmen connected with repair shops, with a view of meeting otherwise difficult jobs with dispatch and economy."

The remainder of the report is taken up with a discussion of the value of hydraulics and compressed air as a means of driving special tools, concluding with a long list of such tools that were furnished to the committee by the several members.

The Committee on the Cost of Maintaining Locomotive opened their report with the statement that it early realized the difficulties in the way of presenting facts and figures to the Association that would be valuable and conclusive. Besides, the figures on performance sheets do not always give the true cost of maintaining the locomotives reported on them, and an intelligent comparison of costs of repairs on different roads is almost impossible because of the various items of expenditure which are often improperly added to or omitted from the account. This difference in the methods of accounting is not chargeable to the mechanical department, but arises from the lack of uniformity of opinions in the accounting departments of the roads.

Besides the methods of keeping accounts there are many other reasons why a comparison of performance sheets is liable to be misleading. The repair account often fluctuates greatly from causes entirely beyond the control of the mechanical or any other department—as, for instance, by the necessity for retrenchment, which may greatly reduce the expenses of the department for a time, only to swell them to unusual figures at a later period. We all have examples of that in the management of railroad properties in the last year. Then, again, the filling of many vacant numbers during one year will cause a bulge in expense of repairs (if charged to this account) which naturally would have been distributed over a longer period.

In addition to all this there are physical characteristics of the road to be considered, the methods of operation and the character of the motive power. The expense of repairs per engine mile for an eight-wheeled locomotive is almost invariably less than for ten-wheeled mogul or consolidation engines, and the road which has a plentiful sprinkling of the latter in its equipment is certain, all other things being equal, to show a higher cost of repairs per engine mile; if the records were made up on the ton-mile basis the result might be quite different. The character of fuel and water also has a marked effect on the cost of repairs, and the effect of heavy grades and curves are too well known to require comment. The speed of trains has a greater influence on the cost of maintenance than is generally supposed. Your committee might cite many cases to show the expense of high speeds, but probably a case that recently came under its notice will suffice. The time of a train scheduled to make 100 miles in 4½ hours, with 6 cars and 27 stops, was reduced to 4 hours, and immediately the fuel bill for that train was increased $100 per month with the same engine and men; and when the running time was changed back to 4½ hours the fuel record at once dropped to its old figures. On the same road it is found that the eight-wheeled engines in fast passenger service cost more for repairs than ten-wheeled engines in ordinary freight service, and no amount of care will bring the expense of the fast eight-wheeled engines below the slower ten-wheeled. The average cost of repairs is also greatest on those divisions whose train speeds average the highest.

From a consideration of all these facts it is evident that no intelligent and exact comparison of performance sheets is possible without an intimate knowledge of all the circumstances and conditions existing during the period covered by the statements, and the difficulties in the way of any work of this committee, based on performance sheets, is made apparent.

A special feature of the subject assigned to us, and the one to which we understand we are to devote our attention chiefly, is the comparison of the cost of maintenance of locomotives built in contract shops with those built in railroad shops. In the circulars your committee issued, members were asked for their opinions and also for figures bearing on this point. We received in reply many opinions and few figures. Some of the members had no experience with contract and railroad-built engines under conditions suitable for comparison, but were of the opinion that the engines turned out of the railroad shops were less expensive to maintain; a few could find no difference, while the majority had found by data collected some time in their experience that the railroad-built engines were cheaper to maintain, the difference in their favor evidently varying from a trivial amount to figures of considerable magnitude. But no opinions or figures were received which would show that in a single case contract-built engines had proved less expensive to maintain than those built in railroad shops. Few of the members furnished actual figures, however, and your committee have not been able to get much exact data, because of the great amount of labor that is entailed in going back over old records and sifting out the desired figures, and for the further reason that in some cases there are objections to making the figures public.

Actual figures have been furnished only by members of the committee itself. Mr. Barr contributes the following: "I give you herewith the average cost of repairs for the first fifteen months of eight of our Class B eight-wheeled engines, built in a contract shop, and six of the same class of engines put in service at the same time and built in our shops. The average cost of repairs for the eight contract-built engines was 2.028 cents, and the average cost of repairs for the six engines of the same class built in our own shops was 1.155 cents. The only other comparison we can make between engines on equal footing is the case of one of our Class C engines, which is a six wheeled switcher that has been in service two and one-half years. The average cost of repairs during that time has been 2.29 cents; nine contract engines of the same class bought at that time have cost on the average 3.45 cents. I have no hesitation in saying that the cost of repairs for the first three years of engines built in our own shops is much less than for engines built in contract shops."

It may be profitable, in connection with this subject, to turn attention to some of the means by which the cost of repairs may be reduced. There are many shop practices and methods of conducting the business of the mechanical department which have their effect upon the cost of repairing locomotives, and to which reference can appropriately be made in this report. The importance of centralizing the work of heavy repairs in one or more large shops on the system, well equipped for doing such work economically, should not be lost sight of. Heavy repairs conducted in small and imperfectly equipped shops not only cost more than at the main shops, but require more time and keep the engine out of service for a longer period than is necessary. This is a serious matter when there is sufficient business to keep all the motive power moving. The only circumstances under which repairs made at small shops would be cheaper than at the main shops would be when there was a large difference in the rate of wages in favor of the small shop. Certain work, however, can be done economically and quickly in the small shop, when the latter is supplied from the main shops with those finished parts for which it has no facilities.

As to whether a road should have more than one large plant will depend wholly upon local conditions, and your committee does not propose that one plant of mammoth proportions should necessarily do the repair work for a large system. But, unless unusual conditions exist, a second plant for heavy repairs should not be considered until the first has become large enough to warrant the installation within it of first-class tools, and every convenience by which the cost of the work will be reduced. This having been achieved, and a greater output being desired, it is a question, depending for answer upon local conditions, whether the increased capacity be obtained by enlarging the plant or building a second one, with the expectation that in a short time it will also be large enough to warrant the installation of a large amount of labor-saving machinery.

In conducting repair work two important considerations should always be kept in mind—the actual cost of the repairs, and the time the engine is kept out of service in making them. Not many years ago comparatively little was done toward the work of repairing an engine before it entered the shops. Now, the time the engine is idle is greatly reduced by keeping on hand, in a partly or wholly finished condition, many such parts as are liable to be needed. Numbers of these parts are standard for all locomotives on the road, and are made without any reference to which engine they will finally be used on; others are more special in character, and may be made for a certain class of engines or even for individual locomotives. Undoubtedly the perfection of this policy will effect still further economies, for not only is the repair work facilitated when the engine comes in, but the parts made in advance of the time are turned out at a reduced cost because the labor on them is performed at such times as it can be done cheapest and most conveniently.

One great source of expense is the repairs which are almost invariably made, whether actually required or not, when an engine comes in the shop to have its tires turned. When the wheels are removed it seems almost impossible to prevent the expenditure of labor upon parts whose condition gave the master mechanic no concern, and on account of which the engine certainly would not have been brought into the shops. Of course, if such refitting is done after careful inspection and with the conviction that the engine can be kept out longer before undergoing a thorough overhauling, the expense may be justified; but your committee is convinced that in many cases the expense is incurred simply because good mechanics cannot resist the temptation to make such parts "just right" before they leave them.

To avoid this expense, and at the same time reduce the number of hours an engine must stay out of service to have its tires turned, a number of roads are keeping turned tires on hand for each class of engines, and when an engine comes in, its tires are taken off the wheel centers without removing the wheels from under the engine, and the newly turned ones shrunk on in their places. The engine is then ready for service in not more than ten hours from the time it entered the shop, and the cast-off tires are turned at the convenience of the shop and held for the next engine of that class which may come in for tire turning. This plan interferes somewhat with tire records, but is most excellent, nevertheless.

Some railroads are carrying out this policy of having new parts all ready for an engine that comes in for heavy repairs, even to the extent of having a boiler entirely ready instead of waiting to repair the original one. Having one extra boiler for a certain class of engines, many of which are approaching the time when extensive boiler repairs will be necessary, the old one is removed, the extra boiler substituted, and the former repaired at leisure, to be put into the next engine of the same class requiring heavy repairs.

It is not the purpose of your committee to argue that this method of procedure can be carried on indefinitely; but if it is the settled policy of the mechanical department to forestall the day of heavy repairs by doing beforehand such work as can be performed with certainty and profit, it will result in keeping the shops more uniformly employed, and in reducing the cost of heavy repairs. A limit to this method of working is reached when the interest on the capital locked up in repair parts awaiting use becomes so great as to counteract the saving effected, but this will never occur when the repair work is judiciously managed.

The standards adopted by a railroad, unless their introduction is carefully watched, may incidentally increase the cost of repairs. Standards are desirable, but their purpose is to reduce expenses and not increase them. Those making repairs should be instructed not to substitute new standard parts when it is possible to refit or repair to advantage the old parts, even if they are no longer standard, true economy in repairs being the ruling idea rather than the pushing of certain standards. Unless this is done, much money will be wasted by the substitution of new "standard" parts for worn parts that are still suitable for service. This matter should be followed closely, as even when the orders concerning the introduction of standards are beyond criticism, the shop in acting upon them is liable to get into expensive ways.

Your committee is also impressed with the fact that the running repairs are frequently not conducted economically because of the absence of facilities at small outlying points, and the lack of care in keeping such places stocked with the supplies and stores they require, and only those. Thousands of dollars are locked up in supplies at these and larger points that have gradually accumulated and for which there is seldom any demand. The stock at each place should be kept as low as possible, and yet it should be of such a character as will fully meet the demands at that point. The endeavor should be, in the main, to avoid making at these small places anything which can be manufactured at the large shops and shipped to them to be kept in stock.

The committee in its circular asks members to state whether they considered their round-houses properly equipped for running repairs, and few of those answering were able to say that theirs were. It is a matter of regret that managements do not realize more fully the economy of proper expenditures on small tools for these points. From the answers of members it appears to be the consensus of opinion that the tools required for running repairs at outlying points where the number of locomotives cared for is about twenty-five, are as follows: One boiler and engine, one lathe, one planer, one drill press, one bolt cutter, one blacksmith's forge, one grindstone, one complete set of hand tools.

This list is subject to some modification according to whether the number of locomotives is greater or less than noted above, and to meet local conditions. But the needs of small points on the road should be carefully studied and ample facilities and suitable supplies provided for them. It will pay in the reduced cost of such repairs as are actually made, and will make it more certain that the stitch which saves nine will be taken in time.

The Committee on Tire Treatment was appointed to report with recommendations diameters for wheel centers greater than 66 in. From the answers received to the question regarding the shrinkage to be allowed per foot of diameter for each size of wheel larger than 56 in., it is found that a majority of the members are using either the Master Mechanics' standard, $\frac{1}{80}$ or $\frac{1}{100}$ in. per foot in diameter of center for shrinkage, and would recommend that these allowances be followed on the larger centers, when future experience will demonstrate the proper shrinkage to use, and the Association will be in a position to recommend the correct amount of shrinkage for all diameters.

In the opinion of the committee, the retaining ring is only put on as a means of safety, to prevent accidents from loose or broken tires; consequently we do not consider it advisable to recommend that tires could be run thinner with a retaining ring than without.

Your committee would recommend the same shrinkage as used for each size of wheel center without retaining rings, for the reason that if retaining rings are used they have been applied to give increased safety.

Concerning the thickness that tires should be considered safe at last turning, your committee find the recommendations vary from 1¼ in. to 1¾ in. for passenger service, from 1¼ in. to 1⅝ in. for freight service, and from 1 in. to 1⅝ in. for switching service. After a careful consideration of this subject we would recommend the limit on passenger tire be placed at 1½ in. for last turning, and the limit on freight and switching tires be placed at 1¼ in. for last turning. The weight on drivers not to be considered, and no distinction made between engines equipped with driver brake and those that are not.

Your committee believe the wear on tires should not exceed ¼ in. in depth before turning on road engines and ⅜ in. in depth for switch engines. We believe the conditions of traffic on railroads govern, in a great measure, the depth tires are worn; for instance, if power is badly needed, engines are often run when the tire should be turned. While we recommend and believe the above limits are good practice, we do not believe an arbitrary rule could be carried out at all times, as the business on a road regulates the number of engines that can be spared from service for tire turning. We believe if above practice were carried out, it would be equally advantageous to the engine and the track.

The last report presented was that of the Committee on Conducting Locomotive Tests. As this committee worked in connection with a similar committee appointed by the American Society of Mechanical Engineers and the report presented is a reprint of the one read before the latter society at its meeting in Chicago last summer, which has already been published in its Proceedings, it is unnecessary to give a *résumé* of it here.

At the session on Wednesday, June 20, the following officers were elected for the ensuing year: President, William Garstang, S.M.P., Cleveland, Cincinnati, Chicago & St. Louis Railroad, Indianapolis, Ind.; First Vice-President, R. C. Blackall, S.M.P., Delaware & Hudson Canal Company, Albany, N. Y.; Second Vice-President, R. H. Soule, S.M.P., Norfolk & Western Railroad, Roanoke, Va.; Secretary, Angus Sinclair, 256 Broadway, New York; Treasurer, O. Stewart, Cambridge, Mass.

STANDARD MOGUL PASSENGER ENGINE, DELAWARE & HUDSON CANAL COMPANY.

In our last issue we published a description of a standard freight mogul engine, as built by the Delaware & Hudson Canal Company at the Oneonta shops, under the direction of Mr. R. C. Blackall, Superintendent of Machinery. We now publish similar illustrations of an engine designed and used in passenger service, which is giving equally good results. The cylinders are of the same size—namely, 18 in. × 24 in.—as those used in the freight engine, but it will be seen from a comparison of the outline sketches that the weights and sizes of the passenger engine are considerably greater than those of the freight. For example, the length of the tender is 18 ft. 7 in. instead of 17 ft. 3¼ in.; the weight of the same has risen from 62,900 lbs. to 75,300 lbs.; the diameter of the boiler is 55¼ in. instead of 50 in., and contains 265 flues 11 ft. 11 in. long, instead of 204 flues 11 ft. 7¼ in. long; the diameter of the drivers is 63 in. instead of 57½ in., and the weight on the same is 109,800 lbs. instead of 86,930 lbs., with practically the same weight on the truck—namely, 13,225, as against 13,070 lbs.

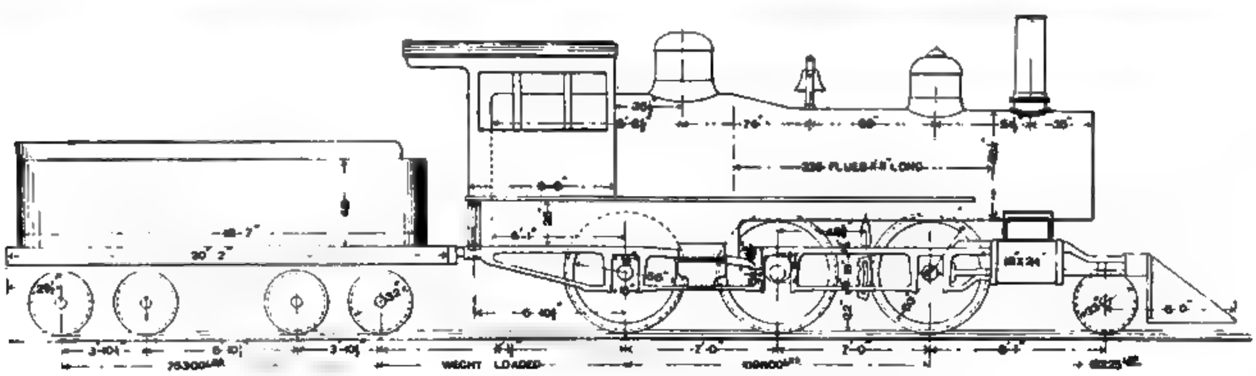
Making a similar comparison in the valve motion, we find that the steam-port is 1½ in. × 17½ in. instead of 1¼ in. × 16 in., with an exhaust of 3 in. × 17½ in. instead of 2½ in. × 16 in. The inside laps of both valves are line in line.

The work of these engines, if carefully watched, will go very far to remove the prejudices which have always existed against the utilization of mogul engines for passenger traffic. Men seem to be afraid of the pony truck at high speed, and yet we know of no instance of derailment that was due to the use of the pony truck. The following are the principal dimensions of the engine:

Kind of fuel used	Anthracite.
Gauge of road	4′ 8½″
Total weight of locomotive in working order	123,025 lbs.
" " on drivers	109,800 "
" wheel base	22′ 1″
Distance between front and back drivers	14′
" from center main driver to center cylinder	53″
Length of fire-box	126″
Width " "	42″
Depth " " (front)	5′ 3″
" " " (back)	4′ 1½″
Water space, side of fire-box	3½″
" " back " "	3½″
" " front " "	3½″
Material of outside of shell	Otis steel.
Thickness of plates outside of shell	7/16″
Material of inside of fire-box	Otis steel.
Thickness of plates inside of fire-box	3/8″
" " " back end	7/16″
" " crown plate	3/8″
Material of tube plates	Otis steel.
Thickness of front tube plates	5/8″
" " back " "	9/16″
How crown plate is stayed	Riveted to bars.
Diameter of dome	27½″
Height of dome	25″
Maximum working pressure per sq. in	150 lbs.
Kind of grate	Water grate.

Width of bars	2"
" between bars	1"
Grate surface	36.75 sq. ft.
Heating surface in fire-box	172.5 "
" " inside tubes	1,283 "
Total heating surface	1,455 "
Single or double blast nozzle	Double.

Greatest travel of slide valve	5⅝"
Inside lap of slide valve	Line and line.
Lead of valve, full stroke (front)	1/16"
" " " " " (back)	1/8"
Throw of upper end of reverse lever from full front to back	57"
Sectional area of steam pipe to cylinder	27½ sq. in.



STANDARD MOGUL PASSENGER ENGINE, DELAWARE & HUDSON CANAL COMPANY.

Diameter of blast nozzle	3⅜"
Smallest inside diameter of chimney	16⅛"
Height from top of rail to top of chimney	14' 4⅛"
" " " " " " center of boiler	7' 6"
Weight of tender empty	44,300 lbs.
Number of wheels under tender	8
Diameter of tender-wheels	33"
Size of tender-journals	3¾" × 7"
Distance from center of main driver to center back driver	7'
Length main-rod, center to center of bearings	7' 4¼"
Transverse distance center to center of cylinders	6' 10½"
Diameter of cylinder and stroke of piston	18" × 24"
Horizontal thickness of piston and follower plate	5"
Kind of piston packing	Cast-iron.
Diameter of piston-rod	3¼"
Size of steam port	1¼" × 17½"
" " exhaust port	3" × 17½"

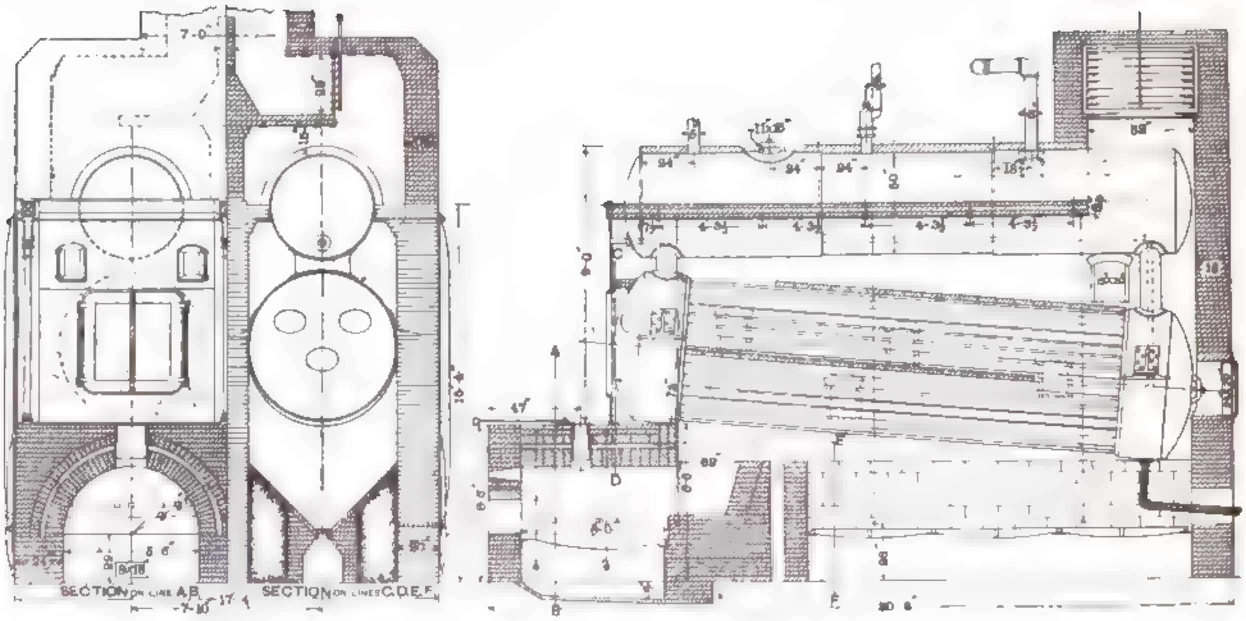
Diameter of driving-wheels outside tires	63"
" " front truck-wheels	33"
Size main axle journal, diameter and length	8"
" other driving axles	8"
Diameter of truck axle journals and length	5½" × 10"
Size main crank-pin journals	6" × 5"
" coupling-rod journals (main)	5½" dia. × 4"
" " " (front and back)	4" dia. × 3½"
Length of driving springs, center to center of hangers	35"
Straight or wagon top	Wagon top.
Material of barrel of boiler	Otis steel.
Thickness of plates in barrel of boiler	9/16"
Kind of horizontal seams	Double-riveted lap with welt.
" " circumferential seams	Double-riveted lap.
Material of tubes	Iron.

Number of tubes	235
Diameter of tubes outside	2".
Distance between center of tubes	2¼"
Length of tubes over plate	11' 11"
Total wheel-base of tender	14' 7½"
Distance from center to center of truck wheels	8' 10½"
Water capacity of tank in gallons of 231 cu. in.	3,300.
Coal capacity of tender	5.5 tons
Total wheel base of engine and tender	47' 10"
" length of engine and tender over all	57' 6"
" " " " " " " " including draw castings	59'

WOOD'S WATER-TUBE BOILER.

Apropos of the recent discussion by the members of the American Society of Mechanical Engineers, in New York, a comparatively new type of water-tube boiler will be interesting. This boiler is illustrated in the accompanying engraving, and is known as the Wood's boiler, and is controlled and built by Wickes Brothers, of East Saginaw, Mich., for the States of Michigan, Wisconsin, Minnesota, Indiana, and Illinois.

The boiler is shown in the setting, known in the saw-mill country as a Dutch oven, which is arranged for burning the refuse from the saw-mill using band saws. The sawdust from these saws is very fine, and when coming from certain kinds of timber, such as hemlock and hard woods, it is very difficult to burn, and mills using tubular boilers set in the ordinary manner have great difficulty in making steam with the refuse or sawdust from the mill. It is necessary to take the slabs



WOOD'S WATER-TUBE BOILER, MADE BY WICKES BROTHERS, EAST SAGINAW, MICH

which come from the logs, pile them in the yard until they dry, and then haul them back to the boilers to be used for the purpose of helping to burn the sawdust. With this setting, as shown, the mill is operated by the sawdust refuse from the mill alone, no slabs being used.

The construction of the fire-box will be very readily seen from an examination of the drawing, and it consists practically of a brick oven, having a fire brick lining with no cooling surfaces whatever. The temperature of this oven is so high that the gases distilled from the damp and green fuel are quickly ignited and burn, and this temperature is also so high that there is no smouldering and bedding down of the fuel. After leaving the fire-box proper, the gases pass over a bridge wall and back to the back end of the water-tubes, passing up around them, and thence to the front and then back beneath the steam and water drum to the stack. This course is readily traced from the engraving. The combustion chamber back of the brick wall is of V-shape, as shown in the right hand cross-section, so that all accumulations, ash, and soot are very readily removed and spaces kept clean.

The boiler consists of a nest of water-tubes expanded into cylinders with dished heads, and connected at either end with water legs extending up to a drum 50 in. in diameter, which is partially filled with water, the steam space being at the top.

The circulation is very rapid in the tubes, so that little scale is allowed to form, and this is materially assisted by the large amount of water carried in the cylinders at the ends of the tubes. Very dry steam is also obtained from the boiler on account of the large capacity of the dome and the large liberating surface of water. A number of evaporative tests show that they compare very favorably with other well-known water tube boilers of similar type.

NOTES AND NEWS.

Cramps and British Warships.—Considerable interest is being manifested by the fact that the Cramps are bidding for the construction of British warships, and whether they get the contract or not is significant that American builders are now entering the field in competition with British builders on their own grounds.

Fire Proof Insulation.—A German electrical paper gives the following recipe for painting electrical wires, making a fire proof insulation. The proportions by weight are about as follows: Forty magnesia, 28 tallow, 15 pulverized asbestos, 30 liquid glue, 15 glycerine, and one-quarter chromate of soda or potassium; to this may be added an additional one-quarter of lampblack if it is desired to make it black.

The "Monteroy's" Plate to be Drilled.—Owing to the alleged frauds which have taken place in armor plates delivered by the Carnegies, it is now reported that the armor plates of the monitor *Monteroy* are to be drilled with a view to making an examination for defects. They are now being examined and photographed. There are to be in all 28 photographs of plates, these will be numbered and the location of the alleged faulty plates marked on them.

Experimental Naval Tanks.—In a recent annual report of the Chief of Construction it was recommended that an experimental tank be added to the equipment of the naval service. These tanks are used for towing the model of a proposed ship, and consist of a long, narrow basin. The tank recommended will be, if made, from 300 to 500 ft. long, about 20 ft. wide, and 9 or 10 ft. deep, having a runway over the centre, from which the model can be towed at any desired speed.

The "Minneapolis."—The preliminary builders' trial of the United States cruiser *Minneapolis* was made early in June with results that were most gratifying. The fuel used was anthracite coal, which served to handicap the vessel to some extent, but in spite of this the reports of the trial show, by the patent logs, that a speed of 21.75 knots had been made. The maximum number of revolutions of the shafts was 138 per minute with 160 lbs. of steam per square inch. It is expected that the official trial will take place at some time before the 15th of this month.

Mahogany Pavements in Paris.—One of the London papers reports that mahogany streets are being laid down on a portion of the Rue Lafayette, in Paris. The blocks used are of real Brazilian mahogany of peculiar fine texture and color. It is an experiment, as the wood is much more expensive than that ordinarily used for the same purpose. The actual cost of the new road will be 50 francs, or about $10 per square yard. It is hoped that the extra outlay will be more than compensated for by the greater durability.

Drainage Canal for the City of Mexico.—The City of Mexico, it is now hoped, will be as healthful for the future as it is beautiful in location. The 30-mile canal with the additional 7 mile tunnel driven through the western mountain range, by which a proper sewerage for the city is at last to be gained, and danger of inundations removed, was formally opened last month. President Diaz, in the presence of the Cabinet and many distinguished men, finished the opening with a silver pick. Then there were informal exercises of rejoicing.

Restoration of Purdue Laboratory.—The restoration of the Purdue Laboratory at Lafayette, Ind., recently destroyed by fire, is being pushed forward rapidly. The locomotive *Schenectady* has been returned to the university from the Pan Handle shops at Indianapolis, where it was put in thorough repair. The engine was backed in over the new track into the Annex laboratory, and directly upon the carrying wheels of the testing apparatus, all under its own steam. This indicates the ease with which the new Annex laboratory may receive any locomotive for testing.

French Railways.—A Paris correspondent of the London *Times* gives an account of the French Railway system. It appears that M. De Freycinet induced the government in 1883 to guarantee to the great railways their average dividend on condition that they would construct an immense network of small railways, their outlay on which was also guaranteed. The work has been executed and has been of great benefit to France, but the treasury and the tax payer are suffering. There is an annual deficit on the general railway account that has risen to $23,200,000 this year, and next year will be $27,000,000. The railways have therefore become a source of perplexity to French ministers of finance.

Electricity in Lighthouses.—It has been decided by the Lighthouse Board that electricity shall be installed as the illuminant at the Fire Island Lighthouse. An appropriation of $15,000 has been allowed for the purpose. The great lens constructed by Lepante, of Paris, and recently exhibited at the Chicago Fair, will be used with the electrical arc installation. This lens was purchased by the Treasury Department for $10,000. Fire Island will thus be the first lighthouse in the United States illuminated by electricity, with the exception of the small beacon on the north point of Sandy Hook. Electricity has, however, been used for some time in lighting buoys in Gedney Channel.

Boring 8,000 Ft. through Rock.—The deepest borehole of the earth is the one at Poroschowitz, in the Rybnik District, Upper Silesia. It has been carried to a depth of something beyond 2,000 meters (about 67,000 ft.), and the diameter of the tube at the bottom is 7 centimeters. Boring to such a depth, and, moreover, through solid rock, was almost impossible prior to the invention of the Mannesmann tube. The greater strength of this tube, as compared with others, makes it possible to use tubes of thinner gauge. It is expected that a final depth of yet another 500 meters (some 1,670 ft.) can be reached, and a number of interesting observations on temperature, etc., will be made.—*Engineering.*

New Smokeless Powder.—A new smokeless powder, discovered by Mr. Leonard, a Virginian, is being experimented with by the authorities of the Naval Ordnance Bureau. In a test made with it a 33-lb. projectile was used with graduating charges. With a charge of 7 lbs. a velocity of 2,054 ft. per second and a pressure of 8 tons at the muzzle was secured; while with 9 lbs. a velocity of 2,300 ft. and a pressure of 11 tons resulted; 11 lbs. of powder gave a velocity of 2,537 ft. and a pressure of 14 tons; and the highest charge used—that is, 12 lbs.—gave a velocity of 2,736 ft., with a pressure of 17.8 tons. The powder is manufactured in solid sticks 24 in. in length by ½ in. in diameter. Recommendation has been made by Captain Sampson for the appropriation of $50,000 to be used for further trial of the powder. The Army has recently purchased 5,000 lbs. for the new small-service arm, and it is said it will be adopted in service.

Damage to the "Resolution."—The London *Times* states that the repairs to the *Resolution*, which was recently caught in a hurricane in the Bay of Biscay, will cost $15,000. At the time of the gale the mess-room and cabin of the ship were knee-deep with water. The *Resolution* labored and strained heavily, and it was feared she would capsize. Her doors were smashed and rivets loosened; then the vessel began to leak badly. Several of the crew were injured. It is claimed that the inclination of the decks reached 35°.

Test of Rapid-fire Guns at Sandy Hook.—The following is the record of the tests of the rapid-fire guns made at Sandy Hook on June 1:

Driggs-Schroeder 6-pdr.—Number of rounds fired in 1 minute, 34; rounds fired in 3 minutes, 88; time to dismount block, remove main spring, rear spring and firing-pin, extractors, one round fired at beginning and end, 2 minutes, 4⅘ seconds.

Hotchkiss—Number of rounds fired in 1 minute, 28; rounds fired in 3 minutes, 83; time to dismount block, remove main spring, rear spring, firing-pin, etc., 1 minute, 87⅖ seconds.

Skoda 3-pdr.—Number of rounds fired in 1 minute, 24; rounds fired in 3 minutes, 55; time to dismount block, etc., 33⅖ seconds..

Sponsel—Number of rounds fired in 1 minute, 24; rounds fired in 3 minutes, 73.

Maxim-Nordenfelt—Number of rounds fired in 1 minute, 20; rounds fired in 3 minutes, 65; time to dismount block, etc., 3 minutes, 33⅖ seconds.

Turrets of the Monitors.—An inquiry has recently been made by the Navy Department as to the efficiency of the turrets of the latest vessels, especially that of the *Monterey*. The report on their performance has been submitted to the department by Captain Kempff, in which he states that while crossing the bar on the trip going out from San Francisco, the vessel ran constantly in the trough of the sea, but gave no greater angle of roll than 16°. Under these circumstances there was a very slight sliding motion of about ⅛ in. of the turret. No blow was brought, however, against the flanges of the rollers, and the turrets showed no sign of lifting on the weather side. The period of roll of the *Monterey* is three seconds, but is not at all jerky. The next day in a rough sea the ship was run in the trough for over half an hour. In the forward turret the greatest sliding motion was $\frac{7}{16}$ of an inch, with an average of ¼ in. At the same time there was a slight rotary motion. The motion was taken up easily and gradually. While rolling from 9° to 14° the turrets were kept in constant motion from extreme train starboard to extreme train port, and the revolving machinery with the usual pressure of 600 lbs. worked the turrets in this condition as regularly and easily as though the vessels had been at anchor in a good harbor. The turret was worked full speed and also slowly, and was at all times under perfect control. The report concludes by stating that there will be no trouble in firing the battery on the *Monterey* in what is generally termed a rough sea. After arriving in port the roller flanges and roller paths were again examined and found in perfect condition.

Specifications for Steel Castings.—Mr. H. L. Gantt, of Philadelphia, has issued a circular regarding the specifications for steel castings, in which he gives the minimum and mean requirements in 2-in. test bars for the two grades of steel castings used by the United States Army in the manufacture of gun carriages. The following table gives the data:

Metal.	Mean.		Minimum.	
	Tensile Strength.	Elongation.	Tensile Strength.	Elongation.
No. 1	60,000	18 %	55,000	15 %
No. 2	70,000	14 %	65,000	10 %

And as a proof that these requirements are not excessive, he quotes the following actual tests which were made from castings delivered to the Army and Navy Department.

Name of Casting.	Weight.	Tensile Strength.	Elongation.
Roller path for 8″ gun carriage......	7,995	73,000	33.20%
Chassis for 8″ gun carriage........	13,500	69,500	31.60%
Stern frame for U. S. Cruiser No. 11. ..	9,213	65,174	32.20%
Box slide for 12″ turret mount	15,000	65,000	25.00%

The tensile strength is given in pounds per square inch, and the elongation is the percentage of increase in the length of

the bar before rupture. The objections to depending wholly upon test bars for an indication of the quality and homogeneity of the metal in a casting are numerous; among which may be noted that to test a very large casting thoroughly by this method, several bars should be taken, representing different portions of the casting. The expense of this method is not inconsiderable, and the delay necessarily incurred is often such as to prohibit its use on any work at all in a hurry. Perhaps the most satisfactory method of obtaining good castings practically available to the general consumer, is to specify the composition of the metal, and that the castings should be properly annealed and have a competent inspector see that the specifications are carried out.

The Hudson River Bridge.—The President has signed the New York and New Jersey Bridge bill, and the next step to be taken by the promoters of the enterprise is to submit the plans, which have already been drawn, for the approval of the Secretary of War. The company must complete the bridge within 10 years from its beginning, spending on its construction at least $250,000 the first year and $1,000,000 a year until its completion. The work will be begun, officers of the company say, as soon as Secretary Lamont approves the plans. The bridge will be a suspended cantilever bridge, and will cost, including approaches, in the neighborhood of $40 000,000. Its promoters say it probably will be completed in four years. At the center it will be 15 ft. higher than the Brooklyn Bridge. The bridge will be purely a railway bridge, with six tracks, for trains of all the railroad systems now terminating on the Jersey shore, including the Pennsylvania, Jersey Central, Erie, Lackawanna, West Shore Ontario & Western, and others. It has been reckoned that 790 trains can pass over the bridge in a day. This project looks toward the erection of a union station on the west side to provide a terminus for all these railroads. According to the company's plans, it is proposed to take two city blocks, each 200 × 800 ft., and bounded by Forty-second, Forty-third, and Forty-seventh streets, by Seventh Avenue and Broadway and Eighth Avenue, giving an area of nearly four acres. On this will be erected two buildings, each 200 × 800 ft., connected by a footbridge over Forty-third Street. These will contain the usual waiting and other rooms and ticket offices, an arrival platform, and a departure platform, each of 20 tracks, a terminal hotel, a general receiving and distributing post office for the city, and a house for express and perishable freight; also 18 stores with their cellars, and about 180 business offices for the railway and for rental. The bridge over the Hudson River will be connected with the station at Broadway and Forty-second Street by a steel viaduct, the average height of which will be 60 ft., and the total length about 10,680 ft.

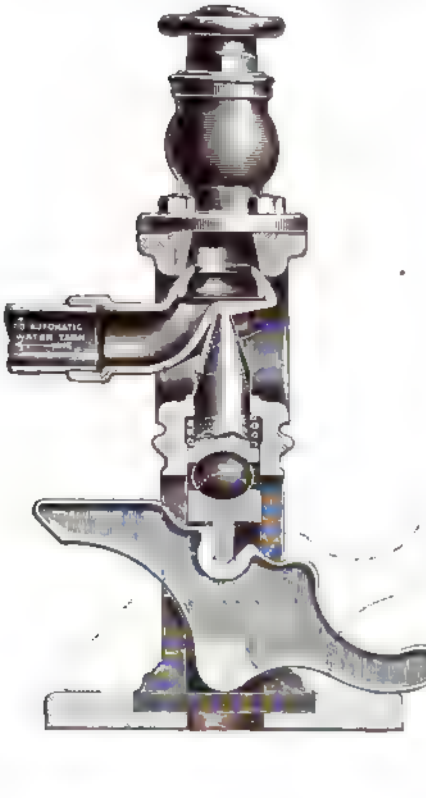


Fig. 1.

Fig. 2.

Canvas Cofferdams.—In a paper read before the American Society of Civil Engineers, Mr M. Meigs, M. Am. Soc. C. E., described the use of canvas in making a cofferdam tight. The method was employed in repairing the locks of the United States Mississippi Canal at Keokuk, Ia., in 1893. Each leaf of the lock gates here was 27 ft. high by 46 ft. wide, and weighed 40 tons, and the leakage of the bottom 10 ft. was becoming serious, hence the need of repairs. The only available time of the year is at the commencement of the frosts in November, when the building of a cofferdam with gravel and timber would have been difficult. It was, therefore, determined to build the dam of timber and make it tight with canvas. A timber frame was accordingly built and towed into place, where its ends abutted on the flaring ashlar walls of the lock approach, while below it was a clear rock bottom. The framing was sunk by loading with old rails, and planks were then spiked on to it. For this purpose a "shot-gun" was used, which consisted of a $\frac{3}{4}$-in. pipe with an iron rod working on it. This pipe and rod extended above the surface, while below it was brought over the spikes to be driven by a diver. The rod was then struck by a hammer at the top. A canvas sheet was then spread over the face of the dam; 12-oz. duck was used, and a $\frac{1}{4}$-in. iron chain was sewn along the lower edge of the canvas to sink it into place. The canvas overlapped the bottom and wing walls by some inches. The work of placing the dam took about five days, after which the lock was pumped dry in about six hours. The leakage was insignificant, the head being 12 ft.

Chinese Railroads. — The first railroad in China was from Shanghai to Woosung, a distance of about 12 miles. Woosung is the bar at the mouth of the Whampoa River, and this road did a big business till some of the Chinese thought it was injuring their luck, and they complained to the authorities. The officials bought the road at a high price from the foreigners who owned it, and threw the locomotive, which they said contained a devil, into the river. Some of the rails are still left, and it may be that the road will be again built in the future. One thing is very certain, and that is the moment the Chinese appreciate that they can make and run roads of their own, their superstition will not stand in the way of making them, and many of the officials are experimenting to see what they can do. A locomotive has recently been built by the Chinese machinists at the Kiaguan arsenal, near Shanghai. Steel rails are also rolled, and the mill is very well managed.

There is a vast deal of waste now, it is true, and this will continue as long as the work is done by the officials, who expect to get a big living out of their stealings: but it will be different when factories of this kind are started as private enterprises. Just now the chief movements in the direction of railroads are from the government, and the idea is to render China impregnable in case of war. This is the purpose of the viceroy at Hankow. He hates the foreigners, and he wants to drive them out of the country. He is using them to build factories, and he has a cotton mill run by steam and filled with modern machinery, which is one of the largest in the world. It contains 1,000 looms, and it is located on the banks of the Yangtse, in the city of Wuchang. It is now making money, I am told, and it is profiting off the rise in foreign cottons through the fall in the value of silver.

Speaking of extravagance in railroad building, it is doubtful whether there has ever been erected a more costly plant than that which is now being put up here by this viceroy for the building of cars, the making of rails, and the turning out of a full equipment for the line which is at some future time to run to Peking. The works are being put up by Belgians as foremen, and about 50 high-priced men are now employed

here on salaries. They are located at the foot of a hill just above the mouth of the Han River and a short distance back from the Yangtse Kiang.

There is a railroad being built in the northern part of the empire, and the regular appropriation set aside for this has been $2,000,000 a year. This northern railway is the only working road in China. It has been pushed rapidly within the past year or so toward the Manchurian frontier, and was of service to the government in the recent rebellion there. It is for the purposes of defense that the Chinese will build railroads.

This northern road was first built to take coal from the mines to the Taku forts and the naval ships. Five years ago it was only about 80 miles long. It has now about reached the great wall, and will soon penetrate Mongolia.—*Halifax Herald.*

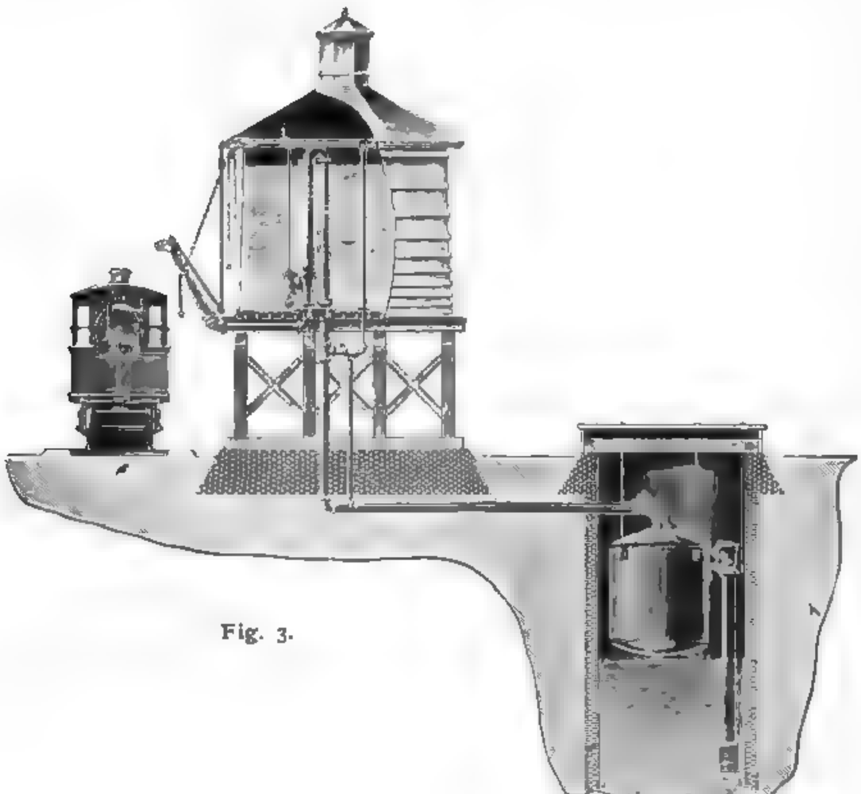


Fig. 3.

AUTOMATIC WATER-TANK.

The Automatic Water-Tank Company, of 148 Liberty Street, New York, have placed an apparatus upon the market which is intended to do away with pumping stations for railroad service. The principal advantages claimed for the apparatus are that its first cost is no more than that of an ordinary pumping station, and, under some circumstances, will be even less, and that it does away entirely with all necessity for attendance, so that the wages of the men who attend these stations as well as the fuel consumed in the boilers used for generating steam to drive the pumps are saved.

The general system by which the apparatus works is that steam is taken from the boiler of the locomotive and carried to the top of a tank filled with water, pressing down upon the surface of the latter and forcing it up through a pipe leading from the bottom of this tank into the tender of the locomotive. The steam which then fills the tank is allowed to condense and thus forms a vacuum, causing the water to rise from the cistern to fill the tank and place the apparatus ready for use with the next engine.

At a recent exhibition of the apparatus that has been set up in Brooklyn, near the line of the Long Island Railroad, from the time the steam was turned into the tank until it was again filled was about two and one half minutes. Details of the apparatus have been very carefully worked out, and our engravings show the arrangements of the same. The side elevation and sectional view in figs. 1 and 2 show the connection which is made at the tender between the steam pipe leading to the automatic water-tank and the pipe from the engine. It will be seen that the pipe leading to the water-tank has a notch on the lower side of an elbow, the top surface of which is fitted into a ball joint at the bottom of the flange, over the top of which the steam enters from the boiler, as shown in the side elevation.

The treadle, which is shown in the release position in dotted lines, is arranged so that it has a cam motion passing the center with a stiff spring over the top which holds the tank pipe up into position and forms the steam pipe joint. The valve at the top of the elbow is then opened and steam admitted to the water tank. The water tank is located below the surface of the track, as shown in fig. 3 It is recommended by the company that there be an auxiliary water-tank above the surface, such as is now used, in order that, in case of failure or leakage or necessity of repairs to the lower tank, the upper one may serve as a storage reservoir from which engines may be filled until the automatic tank has been repaired. Steam enters the top of the automatic tank and presses the water down so that it forces up through the pipe which is shown in dotted lines, and which is turned in the syphon coming down to the spout leading to the engine. These underground tanks have a capacity equal to that of the tender to be filled. When the tender is full the steam is shut off, and an arrangement of check valves causes the water in the stand pipe between the tank and the spout to flow back and be sprayed into the top of the automatic tank rather than to enter it by the pipe from which it left. It thus forms a cooling spray which condenses the steam, producing a vacuum and causing the water to rise through the stand pipe leading down to the water in the cistern. This water then flows into the automatic tank, and always rises to a certain predetermined height.

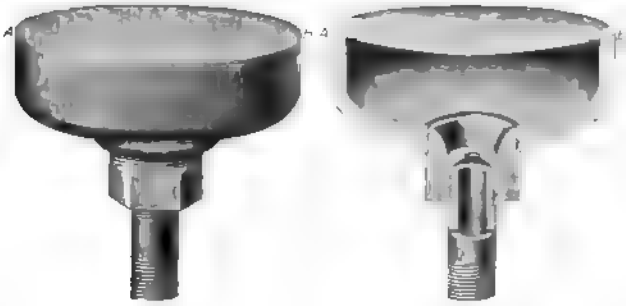
When the tank is made and first set up, steam is admitted in the ordinary way, and, of course, there being no water in the tank, it simply forces the air out through the stand pipes. After a time the steam will condense, and the tank be partially filled from the cistern. Then the second application of steam forces this water out, and its return through the stand pipe causes a complete condensation of the steam and filling of the tank.

The apparatus has been successfully used on one station of the Pennsylvania Road for some months, and an exhibition station, as we have already said, is now in operation in Brooklyn on the line of the Long Island Railroad.

BAKER'S SAFETY VENT.

In the well-known Baker car heater the heat of the fire is conveyed or transmitted to the interior of the car by means of the circulation of water around the fire and through pipes laid near the floor of the car and extending through its whole length. In order to keep the water in the pipes warm they are arranged so that the fire will cause the water to circulate through them and around the fire continuously so long as the latter is kept going. During this process there is no loss of water unless it is caused by leakage. In order that the circulation should be maintained it is essential that the pipes should be completely filled with water. It is, therefore, important that there should not be any leakage of any kind, and that neither water nor steam should be allowed to escape from the heater under its normal condition. But, like a steam boiler, if the heater does not receive the attention it should have, it is liable to be overheated, and under such conditions an excessive pressure may be produced in the pipes, which, if it is not relieved, may produce an explosion. For this reason, and to guard against such contingencies, some means must be provided to relieve the excessive pressure in case of neglect by those who have the care of the apparatus. All ordinary safety valves consist of a number of parts, and are kept tight by some sort of steam joint, and are therefore liable to get out of order and to leak. As a safety valve is only needed in cases of emergency, and is not required in ordinary service of a car

heater, if it is at all complex it is liable not to be in good working condition when the emergency arises. Besides, any leakage, however slight, will in turn reduce the supply of water in the pipes, which will interfere with the circulation. For these reasons—that is, in order to provide a vent, in case of neglect of the heater and consequent overpressure in the pipes, which would have no liability to get out of order and would have no leakage whatever—Mr. William C. Baker, the well-known inventor of the car heater which bears his name, has designed what he calls a "jointless safety vent," which is shown by the engravings (figs. 1 and 2), the former being an external view and the latter a section. This is simply a cup shaped casting with a pipe which is connected to the heater pipes screwed into the lower side, and a flat top, *A B*, which has a groove, *c c*, turned in the under side, so as to reduce the thickness of the metal forming the top around its circumference. The thickness of the metal over the groove is left just sufficient to resist the maximum pressure to which the pipes may



BAKER'S SAFETY VENT

be safely subjected. When it exceeds this point the top is blown out, which, of course, relieved the pressure. The only damage which results is that the old "vent" is destroyed and must be removed and a new one screwed on in its place.

From the illustrations it will be seen that it is almost impossible for this device to get out of order and that no leakage can occur unless by the fracture of the top disk, or, as Mr. Baker expresses it, "there cannot be even a single drop of leak from it until the danger point is reached, when something must give way, and that something is the vent disk. No greater harm is involved in the bursting of the top of this vent than the small expense and the few minutes' time taken in screwing on another one, which may be done by hand."

The blowing off of the vent disk has also the advantage of being a record of the carelessness of the attendant, whereas any ordinary safety valve might blow off repeatedly and leave no sign of that fact after it was closed again.

This device was designed by Mr. Baker to be used in connection with his car heater, but it may be used for other purposes and on boilers of various types and kinds.

The address of the inventor and manufacturer is 143 Liberty Street, N. Y.

THE LESLIE PATENT LOCOMOTIVE FIRE KINDLER FOR KINDLING LOCOMOTIVE FIRES WITH CRUDE OIL INSTEAD OF WOOD

THE apparatus which the inventor of this appliance has devised for the purpose of kindling the fires in locomotives with crude oil instead of wood consists of a suitable storage tank in connection with the engine house or other locality where fires must be kindled, and capable of holding the requisite quantity of oil for the service for which it is intended. A small tank or auxiliary reservoir, which is fed from the storage tank, is also provided, and suitable globe and check valves are located between the two tanks, the former being intended to shut off the whole supply from the storage tank if necessary, and the latter to feed the required quantity of oil to the auxiliary reservoir.

An ordinary air pump, which supplies air to a storage reservoir at a pressure of 60 or 70 lbs. for shop purposes, can be utilized to supply sufficient air for the kindler through a pipe connected with said storage reservoir and entering a locker suitably located in the round house. In this locker an air pressure regulator reduces the pressure to about 20 lbs., and the main air pressure pipe extends from there round the house over each stall; a smaller air service pipe enters the auxiliary reservoir, and passing through the locker, extends, in close proximity to the main air pressure pipe, round the house, and is connected with the latter by suitable branch pipes and the intermediary of a lock combination valve over each stall. An oil service pipe emerges from the auxiliary reservoir, and passing also through the locker, follows the same course as the two former pipes, a branch pipe being connected to the same and also to the lock combination valve above the stalls—the latter is so located as to be conveniently unlocked and opened from the engine. The whole supply of air and oil to these pipes is controlled by suitable valves placed in the locker before mentioned, in which also are located the gauges, all being placed under lock and key, in this way the absolute control of the whole system is in the charge of one person, and when the system is opened to service the control of the supply to each stall is governed by its respective lock combination or regulating valve.

When a fire is to be kindled, sufficient coal is thrown into the fire-box to cover the grate thoroughly; a light and easily handled burner, with two small hose attached for air and oil, is connected by suitable hose couplings to the lock combination valve; after the burner has been connected by unlocking and opening the combination valve, the oil is brought into the house automatically and the air and oil simultaneously admitted to the burner. A small piece of greasy waste is then lighted and thrown into the fire-box on top of the coal; the air and oil are then turned on to the burner by their respective valves, the necessary quantity of oil only being fed automatically, making it impossible to injure the fire-box sheets either through carelessness or otherwise. When the fire has been kindled by the closing of the lock combination valve, the supply of air and oil is shut off simultaneously and the oil remaining in the pipe is automatically returned to the auxiliary tank, after which the burner is disconnected.

The storage and auxiliary tanks are buried in the ground outside of the buildings and below the frost line, fully protecting the oil not only from fire, but also from all kinds of weather, and at the same time economizing space. The location of the pipes over the stalls, where they are entirely out of the way, the means of controlling the whole system by having the controlling valves, including those which are placed out of reach over the stalls, securely locked, so that persons passing through the round house cannot interfere or tamper with them, even the safety and accuracy in kindling fires with this device are not dependent upon the operator, but are due to the fact that those parts which have to be manipulated by him are so arranged that they are either automatically adjusted or it is compulsory for him to adjust them properly to enable him to do the work, in this way protecting the property from all risks through carelessness or otherwise.

The success of this device, it is claimed, has been fully established by actual use in kindling many thousands of fires on several important railroad lines where it has been adopted, and has attracted much attention on account of its cheapness, convenience and the great saving which has been effected through its use. It has been shown that to kindle a fire only 1¼ galls. of oil is required to do what takes one-eighth of a cord of wood, and that as much or more steam will be generated by the oil as by the wood. One car load of oil, = 6,000 galls., will kindle as many fires as 71 car-loads of wood, = 500 cords. The difference in the cost of transporting, handling, sawing and storing the wood and oil is saved by the use of the latter. Less space is occupied by the appliances and the material for kindling with oil than is needed for the wood. Oil is always equally efficient at all times, whereas wood, if it is green or wet, will not kindle readily. In cases of emergency illuminating or lubricating oil may be used. Wood is more liable to be stolen, there is more risk of fire when it is used, and as a larger number of cars are required to transport it, the danger of wreckage is greater. Kindling fires with oil is therefore cheaper, the appliances are simpler, more convenient, cleaner; much time is saved in kindling fires and getting up steam, no wood sparks, which are very liable to start fires, are thrown from the chimney, the annoyance and delay connected with the supply of wood is avoided.

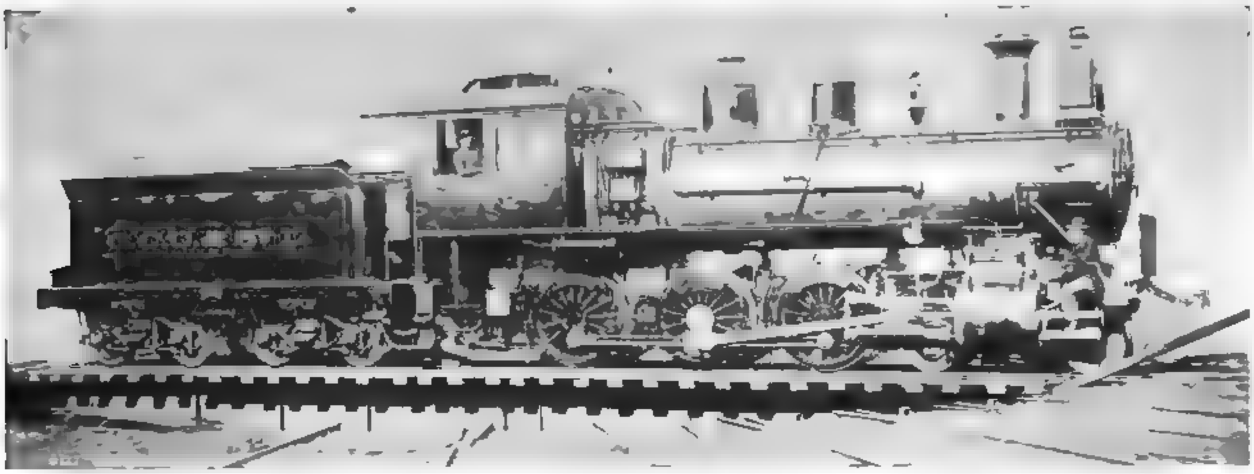
Tests made on the Chicago, Rock Island & Pacific Railroad in kindling fires with one-eighth of a cord of wood and 1¼ galls. of oil showed that there was a very material saving of time in kindling the fire and getting up steam with oil compared with wood. The cost of one-eighth of a cord of wood is 33¼ cents, while 1¼ galls of oil at 1.71 cents per gallon costs only 2 56¼ cents, so that the saving is apparent. The average quantity of oil used to kindle over a thousand fires was only 1.31 galls., and the cost 2.24 cents. In the month of May the average cost on the Burlington, Cedar Rapids & Northern Railroad was just 3 cents. In June it was 1.72 cents. With a little experience with the apparatus the amount of oil consumed to kindle each fire was reduced to less than 3 quarts and the cost was reduced to about 1¼ cents. This apparatus is destined to work a revolution in the method of kindling fires in locomotives, and will largely reduce the cost, the time consumed, and add to the convenience of starting fires and getting up steam.

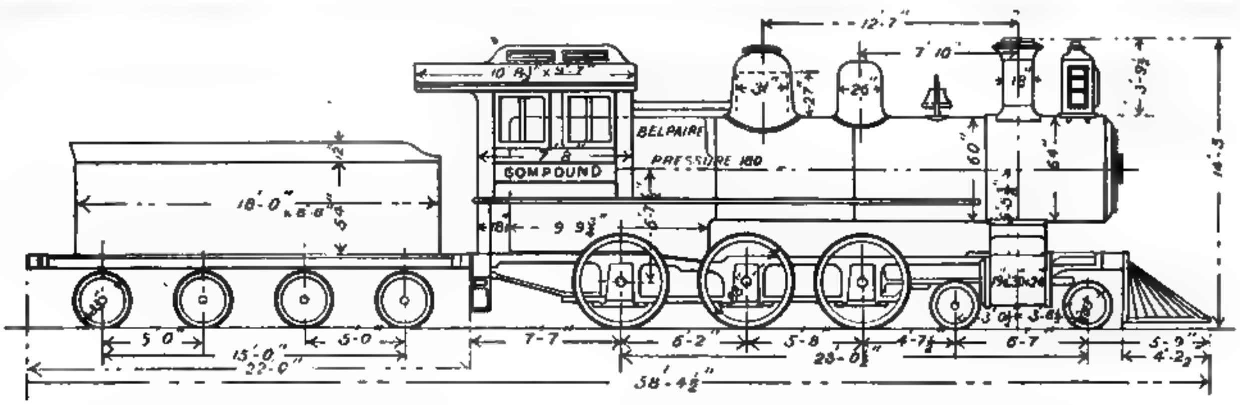
The various patents on this device are owned by Mr. J. S. Leslie, of Paterson, N. J.

RICHMOND COMPOUND LOCOMOTIVE.

Some time ago the Richmond Locomotive Works built a compound consolidation locomotive for the Cleveland, Cincinnati, Chicago & St. Louis Railway, using an intercepting valve designed by Mr. C. J. Mellin, Chief Draftsman of the establishment. The engine has now been working for several months on the road and is giving very good satisfaction, as the relative coal saving effected in its performances as compared with the other engines reported in our April issue would indicate. The engravings of the side elevation in outline and the reproduction of the photograph give a very clear idea of the appearance and construction of the engine, and the following are among its principal dimensions :

Kind of fuel used	Bituminous coal.
Gauge of road	4' 8½"
Total weight of locomotive in working order, including two men, from scale with two gauges of water	141,400 lbs.
Total weight on driving-wheels (about)	112,000 "
" wheel base	23' ½"
Distance between center of front and back driving-wheels	11' 10"
Inside lap of L.P. slide valve	1/16"
" " " H.P. " "	1/16" and ⅛"
Outside lap of L.P. slide valve	¾"
" " " H.P. " "	¾"
Lead of slide valves L.P. in full stroke	⅛"
" " " " H.P. " " "	1/16"
Diameter of driving-wheels outside of tires	56"
" " front truck-wheels	28"
" " back truck wheels	28"
Size of main driving-axle journal, diameter and length	8" × 9½"
" " other " " " " "	8" × 9½"
" " truck axle journals, diameter and length	5¾" × 10"
" " main crank-pin journals, diameter and length, internal	6" × 5"
Size of main crank pin journals, diameter and length, outer	5½" × 6½"
" " coupling-rod journals, diameter and length,	4" × 4"
Length of driving-springs, measured from center to center of hangers	36"
Description of boiler	Belpaire.
Inside diameter of smallest boiler ring	60"
Material of barrel of boiler	Steel.
Thickness of plates in barrel of boiler	5/8"
Kind of horizontal seams	Double-riveted butt seams.
" " circumferential seams	Double-riveted lap seams.
Material of tubes	Lap-welded iron.
Number of tubes	241





COMPOUND LOCOMOTIVE, BUILT BY THE RICHMOND LOCOMOTIVE WORKS.

Distance from center of main driving-wheels to center of cylinders	13' 4"
Distance from center of main driving-wheels to center of back driving-wheels	6' 2"
Length of main connecting-rod from center to center of journals	9' 1"
Transverse distance from the center of one cylinder to the center of the other	7' 4"
Diameter of L.P. cylinder and stroke of piston	30" × 24"
" " H.P. " " " " "	19" × 24"
Horizontal thickness of piston over piston-head and follower plate	6"
Kind of piston packing, H.P.	Dunbar.
" " " " L.P.	Simple rings.
Diameter of L.P. piston-rod	3¾"
" " H.P. "	3½"
Size of steam L.P. port	23" × 1¾"
" " " H.P. "	23" × 1¼"
" " exhaust L.P. "	23" × 3¼"
" " " H.P "	23" × 2½"
Greatest travel of L.P. slide valve	5¾"
" " " H.P. " "	5½"
Diameter of tubes, outside	2"
Distance between center of tubes	2¾"
Length of tubes over tube plates	13' 10 1/16"
" " fire-box	8' 11 1/16"
Width " "	3' 5¾"
Depth " "	5' 1¾" to 5' 7¾"
Water space, side of fire-box	3½"
" " back of fire-box	4"
" " front of fire-box	4"
Material of outside shell of fire-box	Carnegie steel.
Thickness of plates of outside shell of fire-box	5/16"
Material of inside fire-box	Carnegie steel.
Thickness of plates inside	⅜"
" " " back end of fire-box	⅜"
" " crown-plate	⅜"
Material of tube-plates	Carnegie steel.
Thickness of front tube-plates	½"
" " back tube-plates	½"
How crown-plate is stayed	Vertical and horizontal stays.
Diameter of dome	31"
Maximum working pressure per sq. in.	170

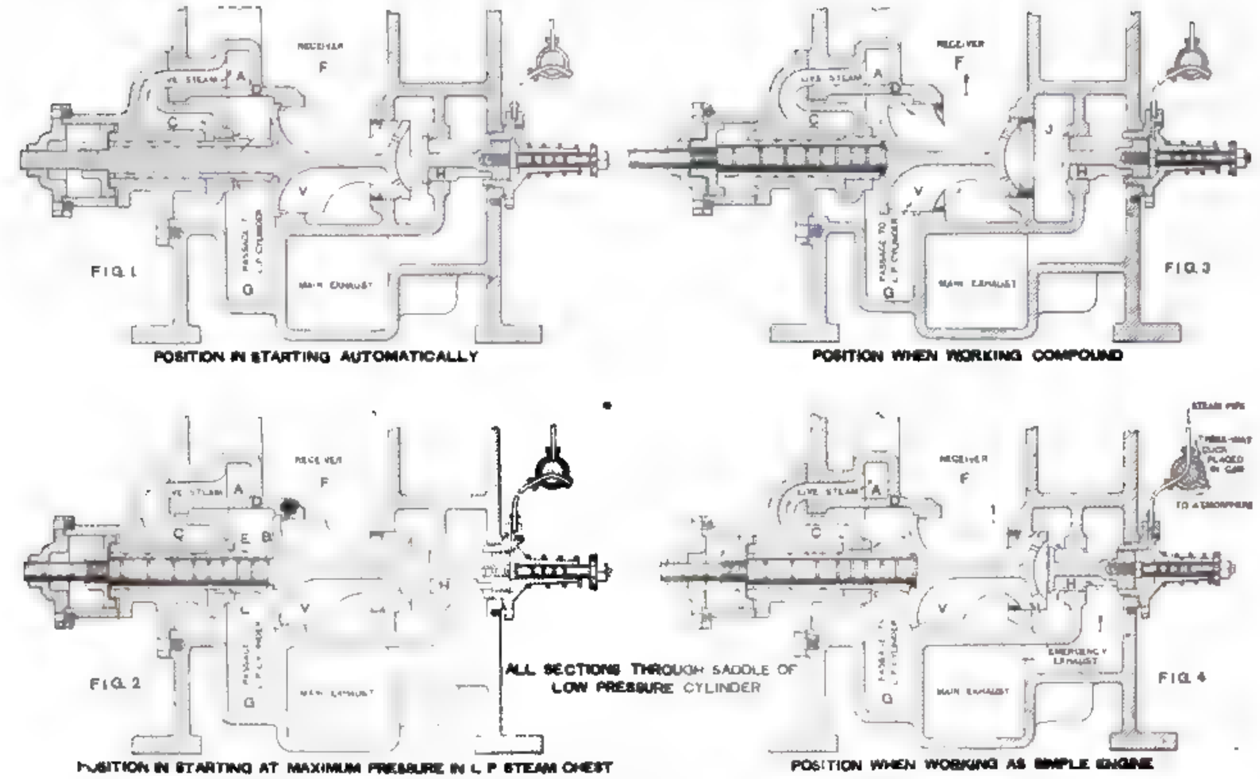
Kind of grate	Rocking finger.
Width of opening between bars (or tubes) about	1 in. between fingers.
Grate surface	31.3 sq. ft.
Heating surface in fire-box	172 "
" " of the outside of tubes	1,756 "
Total heating surface	1,928 "
Kind of blast nozzle	Single.
Diameter of blast nozzle	5¼"
Smallest inside diameter of chimney	15"
Height from top of rails to top of chimney	14' 5"
" " " " " center of boiler	7' 11½"
Weight of tender empty	41,650 lbs.
Number of wheels under tender	8
Diameter of tender wheels	33"
Size of journals of tender axles, diameter and length	4½" × 7½"
Total wheel-base of tender	15' 0"
Distance from center to center of truck wheels of tender	5' 0"
Water capacity of tank (in gallons of 231 cu. in.)	4,000 galls.
Total wheel-base of engine and tender	49' 1½"
" length of engine and tender over all	58' 4½"
Throw of eccentrics	5½"

The intercepting valve, as we have already said, was designed by Mr. Mellin, and its construction is very clearly shown by the engravings which we present, in which the various positions which it occupies while in service are represented.

Fig. 1 shows the position starting automatically, fig. 2 the starting position at the maximum pressure in the low-pressure steam chest, fig. 3 when working compound, and fig. 4 the position when working as a simple engine.

The drawings show sections through the low-pressure cylinder saddle with the valves in their various relative positions. The high-pressure cylinder exhausts into the receiver, which is placed inside the smoke-box and opens into the chamber *F*. The intercepting valve, as shown at *V* in the several views, has a piston on its forward end which acts in its cylinder as an air dash-pot, to prevent any slamming of the valve. Around the stem of this valve is a sleeve, *L*, which has an axial movement on the stem, and acts as an admission and reducing valve to the low-pressure cylinder when starting and when working simple. Valve *H* is a plain winged valve with a piston on its rear end, and is called the emergency valve, as by its use the engineer can at will operate as a simple engine. When starting, steam from the boiler goes to the high-pressure cylinder in the ordinary way, and also to the port *C* through a 2-in. steam pipe connected to the dry pipe. There is then no pressure in the receiver *F*, and the pressure on the shoulder *E* of the sleeve *L* (fig. 2) moves the sleeve and valve *V* to the right, closing the receiver and letting steam past the shoulder *E* into the low-pressure valve chest *G*.

Now, since the area of the end *B* of the sleeve *L* is, say, twice that of the shoulder *E*, half of the boiler pressure will move the sleeve *L* to the left, cutting off steam from port *C*, and thus equalizing the work in both cylinders. After, say, one and a half revolutions, the pressure accumulates in the receiver *F* and moves the valve *V* to the left, carrying the sleeve with it, when, the steam being permanently cut off at *C*, there is a straight connection between the two cylinders. In starting on grades, or when exerting maximum power, the engineer can move the three-way cock in the cab, letting boiler steam behind the piston on the emergency valve *H* and holding it open against its spring. This exhausts the small cavity *J* in which the pressure is equalized with the receiver through holes in the valve *V*, and then the valves *V* and *L* move instantly to the right, assisted by steam pressure on the shoulder *E*. The high-pressure cylinder has now a separate exhaust, and the low-pressure cylinder gets its steam direct from the boiler through the port *A* and reducing valve *L*. Except when working simple the valves act entirely automatically. The lubricator to the low-pressure cylinder enters port *A*, and thus insures constant lubrication to the intercepting and reducing valves.



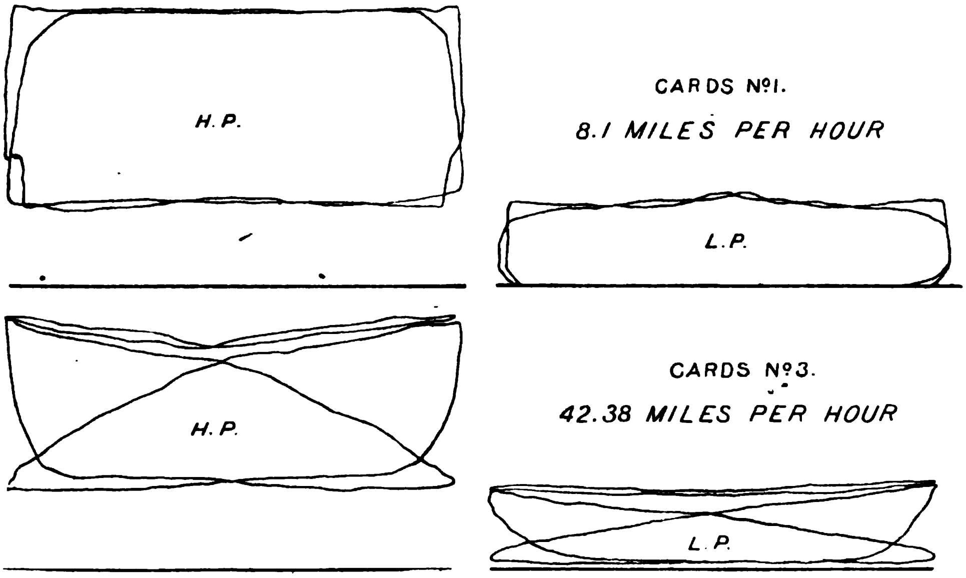
MELLIN INTERCEPTING VALVE FOR COMPOUND LOCOMOTIVE, BUILT BY RICHMOND LOCOMOTIVE WORKS.

Owing to the small area of port *C* and the contracted exhaust through *H*, the engine develops less power as a simple engine than as a compound at a speed of over, say, 5 miles an hour, and thus the runner is compelled to work compound.

Should *either* side break down, the emergency valve can be opened and the engine brought in on one side like an ordinary engine.

To recapitulate. It will be seen, then, that in fig. 1, where the engine is simply started by opening the throttle, steam enters the low-pressure cylinder from the dry pipe through the 2-in pipe *A*, the passage *B*, and passes by the opening made by the sleeve *L* into the steam passage to the low-pressure cylinder. Meanwhile, the high-pressure cylinder is exhausting into the receiver and raising the pressure there and in the chamber *J*. As soon as the pressure in the low-pressure steam-chest is one-half of that in the dry pipe, the pressure against the sleeve *L* at *B* pushes it back into the position shown in fig. 2. This, of course, is only temporary, because the moment steam is admitted again into the low-pressure cylinder pressure is reduced in the chamber *G* and the sleeve moves back to its position of fig. 1. As soon, however, as the receiver pressure and that in the chamber *G* rises so as to be slightly in excess of that in the passage to the low-pressure cylinder *G*, the whole intercepting valve is thrown back into the position of fig. 3, and at that point live steam, entering at *A*, is cut off by the sleeve *L* and the exhaust steam passes direct from the high-pressure cylinder through the receiver into the low-pressure steam-chest, as shown in fig. 3.

When the engine is to be worked as a simple engine, as has already been said, the valve is moved into the position of fig. 4 ; steam then enters at A, passes through C around the opening at L into the low-pressure cylinder. The exhaust from the high pressure cylinder passes through the receiver around the dash pot piston of the main valve through the chamber J, passes the valve H and out into the main exhaust by way of the emergency exhaust, as marked. The action of the engine is very clearly shown by the two sets of indicator cards which we publish. One of them is taken at the speed of 8.1 miles per hour, and the other at 42.38 miles per hour. In the first the lever was down in the corner, the steam pressure 170 lbs., the engine making 50 revolutions per minute. The mean effective pressure in the high-pressure cylinder is found to be 114 lbs. ; in the low-pressure cylinder it is 48 lbs. The H.P. developed was 196 in the high-pressure and 205 in the low-pressure cylinder, making a total of 401, thus showing that the equalization of work done by the two cylinders is practically perfect, the actual variation being less than 5 per cent.



INDICATOR CARDS FROM COMPOUND LOCOMOTIVE, BUILT BY THE RICHMOND LOCOMOTIVE WORKS.

In the other cards where the speed was higher the boiler pressure was 155 lbs., the cut-off was at 15 in., and the engine was making 260 revolutions per minute, with a mean effective pressure in the high-pressure cylinder of 64 lbs. and 26 lbs. in the low pressure, developing a H.P. of 572 and 578 lbs. in the high and low-pressure cylinders respectively, making a total of 1,150 H.P. The variation here, it will be seen, was only 6 H.P., which amounts to a trifle over 1 per cent. It is interesting to note the saving of fuel reported in connection with the performances of this locomotive, which runs from 30 to 35 per cent., according to the published reports. The details of the tests by which this saving has been effected are not at hand, and it is therefore impossible for us to make an analysis of them to determine whether the whole or only a part of the actual saving was due to the compound principle.

SOME ENGINES OF THE GERMAN RAILWAY UNION.

The last supplement of the *Organ*, which appeared in 1893, contained a description of a number of types of locomotives, passenger and freight cars which have been put into service during recent years on the different lines of the German Railway Union. We select from this work, which contains a large number of interesting reports, a description of three express engines, two of which differ from types which are in general use.

Express Locomotive for the Bavarian State Railways.—These locomotives, fig 1, were built by Mafei, of Munich, in 1891, for four wheels coupled at the back with a bogie truck in front. The cylinders and steam-chests are outside the frames, and the distance from center to center is 6 ft. 8 in. The boiler is of iron and the fire-box of copper. The shell is formed of three sheets with an average diameter of 4 ft. 7 in. and a thickness of .6 in. The transverse and longitudinal seams are double riveted, which was done with a Tweddell hydraulic riveter. The iron sheets used in the construction of the boiler have a tensile strength of 51,260 lbs. per square inch, with a minimum elongation of 18 per cent. At a service pressure of 180 lbs. per square inch these sheets are subjected to a strain of 7,100 lbs. in the full and 9,700 lbs. at the riveted joints.

The thickness of the tube sheets is 1 in., and while the crown sheets is ¾ in. and the side sheets ⅝ in., the outside shell of the fire-box is .7 in. thick, and is connected to the crown-sheet by stay-bolts riveted to the outside and provided with nuts under the crown sheet; the two rows of stay-bolts alongside of the tube-sheet are so arranged as to permit a free expansion. The tubes are of iron, and the fire-box is provided with an arch as well as a deflector above the door, which is furnished with openings allowing air to be admitted into the fire-box. The grate is divided into three parts, and is inclined toward the front end. Two safety-valves 4.33 in. in diameter are located over the fire-box. The dry-pipe is in a dome placed on the second sheet of the shell, and the throttle-valve is a double valve. The smoke-box is provided with a spark-arrester and has a length of 3 ft. 11¼ in., and is provided with Adams's vortex blast-pipe. The frames are composed of four sheets of steel 1 in. thick rigidly stayed together by means of transverse plates. The spacing of the sheets of the frame is less at the front end than at the back, the difference being 2¾ in., thus permitting a lateral movement of the bogie; this latter is arranged as in the engines of the South-eastern Railway of England. The boiler rests on two coupled axles at the back by means of two lateral equalizing levers outside the frames. The Walschaert valve-motion is used. The locomotive is provided with the necessary apparatus for heating cars with steam; a Petri steam indicator placed over the running board near the engineer. Nathan oilers are used for lubricating the cylinders and valves. The tender has three axles and carries 27,120 lbs. of water and 6 tons of coal. In addition to the Westinghouse brake it is also provided with the Exeter brake. The tender wheels have a diameter of 3 ft. 2¾ in. The brake-shoes work on each side of the six wheels. The weight of the tender empty is 13 tons, and in service it is 32 tons. The total wheel-base is 10 ft. 10 in. The principal dimensions of the engine are as follows :

Diameter of cylinders	1′	5″
Stroke of pistons	2′	0″
Diameter of driving-wheels	6′	1″
" " truck wheels	3′	3¼″
Center to center of truck-wheels	7′	2½″
" " " " driving-wheels	8′	4⅜″
Total wheel base of engine	21′	10⅝″
Outside diameter of tubes		1¾″
Inside " " "		1⅝″
Length of tubes	12′	9⅝″
Number "	218	
Heating surface in tubes	1,308½ sq. ft.	
" " " fire-box	106½ "	
Total heating surface	1.415 "	
Grate area	23.68 "	
Boiler pressure	180 lbs. per sq. in.	
Weight in working order on front axle	23,152 lbs.	
" " " " " second axle	24,650 "	
" " " " " third "	30,870 "	
" " " " " fourth "	30,870 "	
Total weight	108,542 "	
" " on drivers	61,740 "	

Express Locomotive with Lentz Boiler, for the Left Bank Railways of the Rhine.—This locomotive, fig. 2, was built in 1892 by the Hohenzollern Works, at Düsseldorf. It has four wheels coupled at the back with a bogie in front. There are outside cylinders placed horizontally in the transverse center line of the bogie. Outside valve gearing of the Joy system is used.

The frames are formed of two plates 1 in. thick stayed together by transverse plates, and along the whole length of the frames by a horizontal sheet riveted along the center of the main frame pieces.

The boiler rests at the front end upon a bogie like that used upon the Italian express locomotives of the Mediterranean Railway. The pivot and the piston which rests upon it are of cast steel; spiral springs are used placed on outside of the bogie, and which resist a forward motion of the engine, yet the inclined equalizers permitting a lateral movement of the bogie. These equalizers are arranged so as to take up the movement and lateral pressure which result when there is no play between the rail and the flange of the wheel.

On roads of	Lateral movement.	Lateral pressure.
3,280 ft.	⅝ in.	108 lbs.
984 "	1 ft.	2,778 "
590 "	1 ft. 8 in.	4,432 "

The boiler is formed of three sheets .7 in. thick. The center one is cylindrical with a diameter of 5 ft. 4¾ in. The front and back ones are conical, with a diameter at the extreme ends of 4 ft. 1 in. and 4 ft. 1⅜ in.; the back is, furthermore, inclined to the center line of the boiler. There are no longitudinal seams, the sheets being welded. The smoke-box is fastened to the frame, and the boiler rests at the back end upon two lateral bars fastened to the frames. A pivot placed in the center below the fire-box resists all movement of the boiler. The corrugated fire-box, which occupies the back sheet and the greater part of that in front of it, has an inside diameter of 8 ft. 7½ in. and an outside diameter of 8 ft. 11½ in. The grate is horizontal and in two parts; its length is 6 ft. 10 in. It rests at the front end upon a stay of cast iron surrounded by fire-brick, and in front of this stay is the combustion chamber where the gases are burned. The fire-box tube-sheet carries the whole strain of the expansion of the fire-box and the tubes; it is only ¼ in. thick. The tender carries 3,960 galls. of water and 5 tons of coal.

The principal dimensions of the engine are as follows:

Diameter of cylinders	1′	5″
Stroke of pistons	2′	0″
Diameter of driving-wheels	6′	5⅛″
" " truck-wheels	3′	2⅝″
Center to center of truck-wheels	6′	6¾″
" " " " driving-wheels	7′	10⅛″
Total wheel base	21′	5⅞″
Outside diameter of tubes	1.8″	
Inside " " "	1.6″	
Length of tubes	9′	6″
Number "	241	
Heating surface of tubes	1,003	sq. ft.
" " " fire-box	119	"
Total heating surface	1,122	"
Grate area	21½	"
Boiler pressure	210 lbs.	per sq. in.
Weight in working order, front axle	23,700	lbs.
" " " " second axle	23,700	"
" " " " third axle	33,070	"
" " " " fourth "	33,070	"
Total weight	113,540	"
" " on drivers	66,140	"
Weight when empty	100,212	"

Express Locomotive for the Würtemberg State Railways.—This locomotive, built by the Société Cockerill, of Seraing, in 1892, is intended to haul trains weighing 150 tons up continuous grades of 10 per cent. at a speed of 37 miles per hour.

The frames are inside and the engine rests upon the two coupled driving-axles, which are placed between two carrying-axles, one of which is at the front and the other at the back beneath the fire-box. These two latter axles are radial, so that the engines can run over curves of 490 ft. radius. Fig. 3 shows the arrangement which permits this radial axle; a connecting-rod *a* is attached to each axle at the points *b* and *c* by vertical levers *d g* and *e f*, which turn about the fixed points *d* and *e*; one rod, *f g*, is fastened to the back end of each of these back levers, and when one of the axles becomes radial its conjugate takes the same position. The same arrangement exists on each side of the engine. The connection *g f* is prolonged to *o*, where it is fastened to the lever *o p m*; this lever is fastened at *m* to a horizontal equalizing lever *m l n*, which turns about the fixed point *l* while its end is fastened to the tender. It thus assumes an oblique position relatively to the locomotive; the equalizing lever turns about the point *l*, and in consequence of the position taken by the points *m m*, the axles assume a radial position.

The boiler is of mild steel, having the maximum resistance of 64,000 lbs. per square inch and a minimum resistance of 54,000 lbs. per square inch, with an elongation of 25 per cent., and has been calculated for a working pressure of 225 lbs. per square inch; it has been tested, to 255 lbs., but in regular service the pressure is only 180 lbs. The crown-sheet is strengthened with stay-bolts. The boiler is prolonged at the front end by a smoke-box having a length of 6 ft. The engine has three cylinders of the same diameter, which can be made to work either compound or in the ordinary way. For this purpose a steam-chest receiving the steam directly from the boiler is placed above the center cylinder. According to the position occupied by a valve placed in this box, the steam from the boiler enters the second cylinder, and thence through an intermediate receiver it passes into the side cylinders, where it expands and finally escapes through the exhaust. By reversing the position of the valve in this distributing chest the steam from the boiler enters the intermediate receiver directly, and thence passes into each of the lateral cylinders and also into the center cylinder, whence it escapes into the atmosphere; the locomotive is then working as a non-compound. For the sake of obtaining an equal amount of work in the side cylinders while working compound, a valve which prevents the pressure in the outside cylinders from exceeding half of that of the center cylinder is used. The side cylinders are outside and are provided with Allen valves; the center cylinder has a Walschaert valve gear; the three cylinders drive the same axle, which is the forward driving-axle. The following are the principal dimensions:

Diameter of cylinders	1′	4⅛″
Stroke of pistons	1′	10″
Diameter of driving-wheels	5′	5″
" " truck wheels	3′	5″
Distance from center to center of driving-wheels	7′	
Total wheel base	19′	
Outside diameter of tubes		1¾″
Inside " " "		1⅝″
Length of tubes	14′	1″
Number "	250	
Heating surface in tubes	1,490	sq. ft.
" " " fire-box	103	"
Total heating surface	1,593	"
Grate area	21⅛	"
Boiler pressure	180 lbs.	per sq. in.
Weight in working order, front axle	28,670	lbs.
" " " " second axle	30,434	"
" " " " third axle	30,434	"
" " " " fourth axle	29,992	"
Total weight	119,530	lbs.
Weight on drivers	90,840	"
" empty	105,217	"

TRANSPORTATION OF A TORPEDO BOAT FROM TOULON TO CHERBOURG.

By M. Partiot.

The possibility of effecting a passage of a torpedo boat over the railways having been determined, I thought that it would be well to inform the quartermaster at the Navy Department to that effect, so that if he wished to avail himself of this method of transportation, I could put myself at his disposal in order to make the test. Admiral Aube, who was at that time Minister, directed the quartermaster to instruct me to carry out this affair, and examine into the transportation of a torpedo boat having a length of 108 ft. 3 in. from Cherbourg to Toulon. I then transmitted officially the schedule of my first investigations to the Minister of Public Works, who transmitted them to his colleague. I forwarded one to the directors of the Paris, Lyons & Mediterranean Company and to their staff, and received from them their assurances of the utmost assistance in the difficult task which I had undertaken in the interest of national defense. There still remained, however, some questions to solve, and they gave rise to long and careful examinations.

The Navy Department had first to make an examination to see whether, when a torpedo boat was set upon two trucks, with its ends overhanging 36 ft. 5 in. from the cradles, the sheets would not be too thin to sustain it in this position, as well as to withstand the shocks of transportation without being deformed, and especially without cracking. This examination was made by the naval engineers, who decided that the sheets would only have to carry, with this method of loading, a strain which was very much less than their tensile strength. Nevertheless, experience was the only thing that could determine definitely regarding the dangers of oscillations which might occur *en route*. It then became necessary to choose a convenient route. This was done by the railway companies. They preferably chose single-track roads, because the passage could then be made without any passings, and the breadth of the load was not limited by half the breadth and the narrow distance between the rails.

Furthermore, the maintenance of the track sometimes requires the ties to be raised when the normal height of the rails is not the same as that indicated by the maps in the neighborhood of permanent structures, and the clear space between the structures and the outside rail might possibly have been diminished. Finally, on curves, the track tends to be dis-

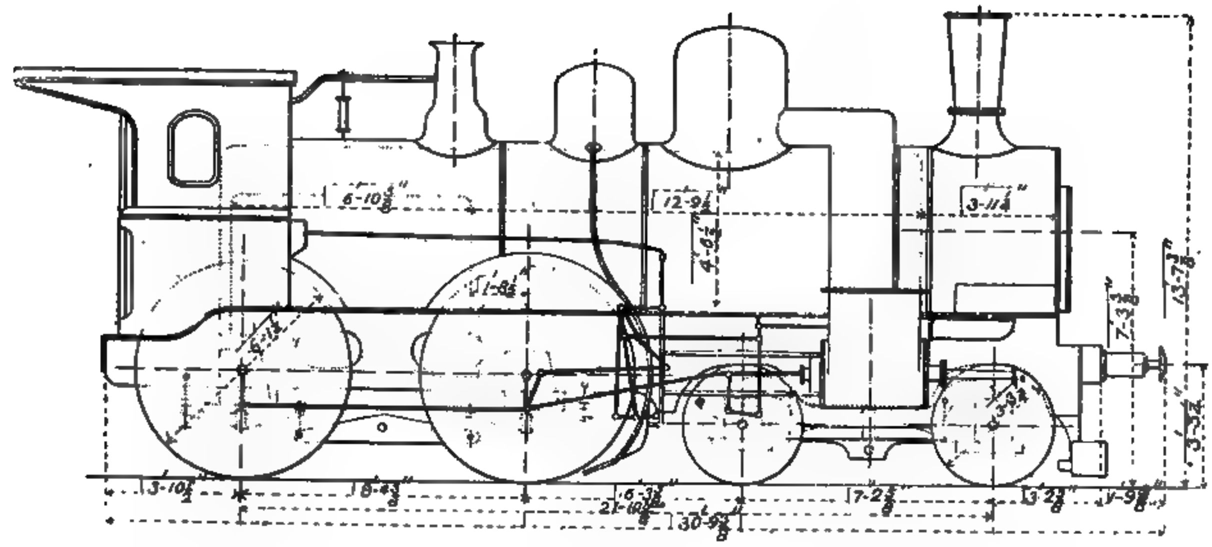


Fig. 1.

EXPRESS LOCOMOTIVE FOR THE BAVARIAN STATE RAILWAYS.

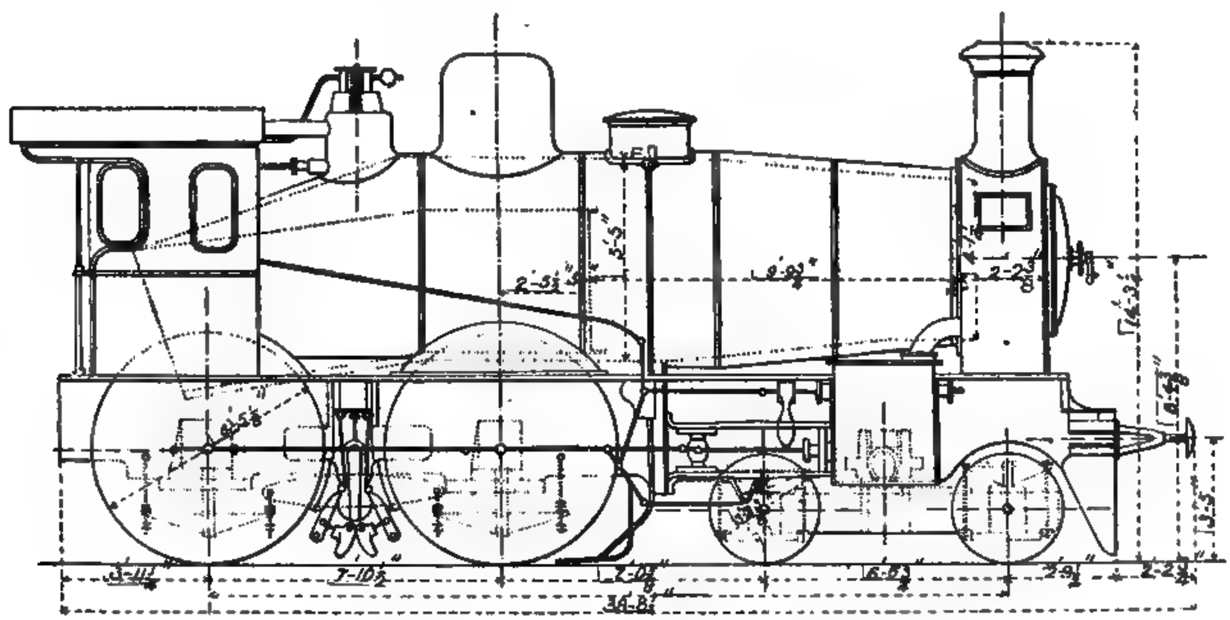
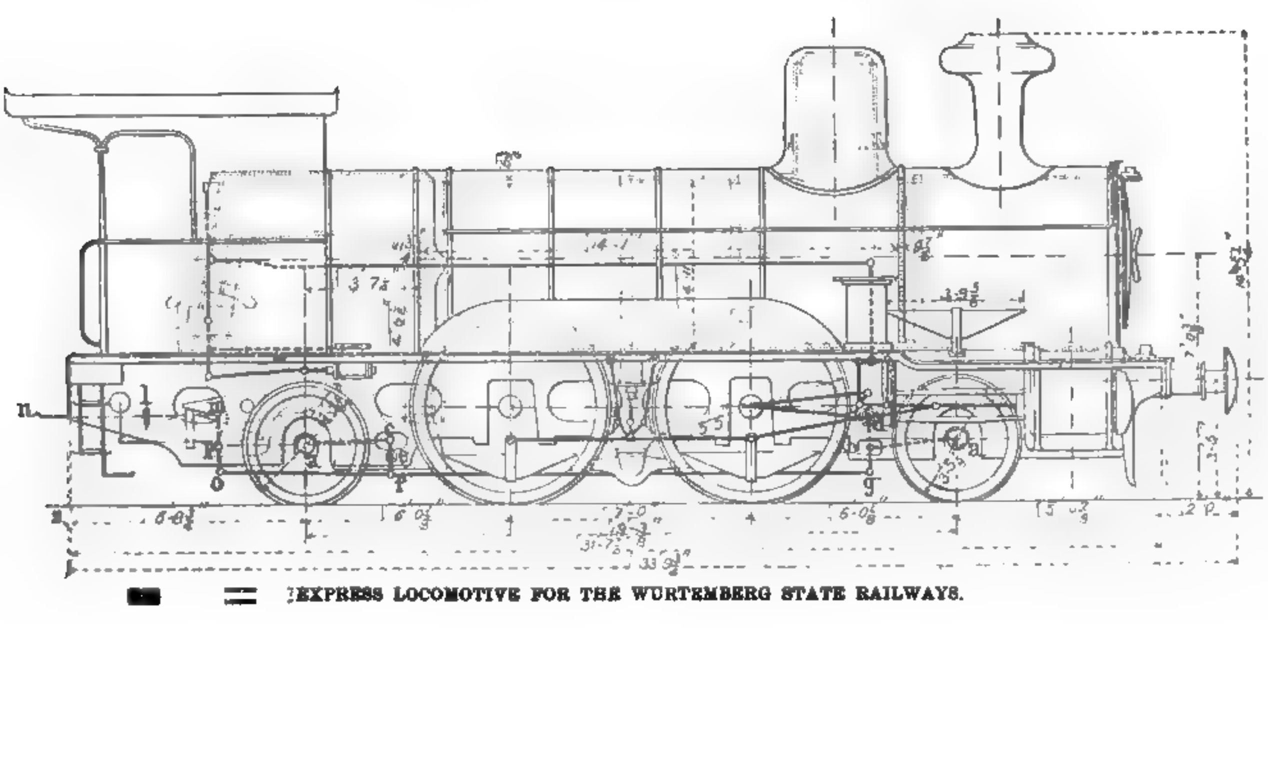


Fig. 2.

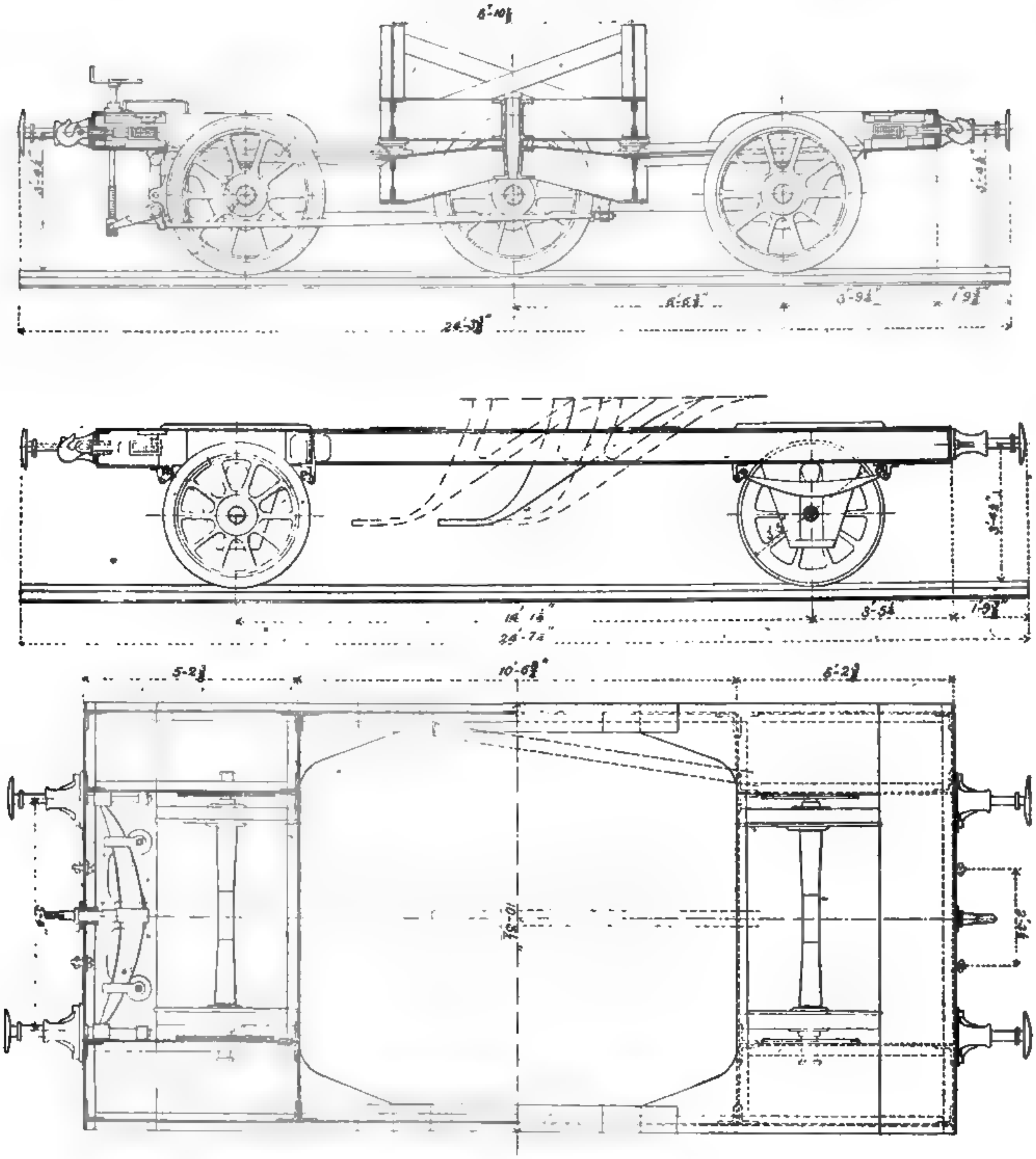
EXPRESS LOCOMOTIVE WITH THE LENTZ STAYLESS BOILER, FOR THE RAILWAYS ON THE LEFT BANK OF THE RHINE.



EXPRESS LOCOMOTIVE FOR THE WURTEMBERG STATE RAILWAYS.

placed by the passage of rapid trains, so that it might possibly come nearer obstructions which stand alongside the track. In order to make certain of the possibility of the passage of a torpedo boat, and determine what work was necessary to be done in order to accomplish it, the companies had a car run over the route which had projections upon it that represented effected even in the old line from Mezidon to Mans were very slight indeed.

As the method of setting the torpedo boat upon its truck might lead to serious accident, either to the boat itself or to the truck, the railroad company stipulated that the consequences thereof should be at the expense of the Navy Depart-



Figs. 1, 2, and 3.

SPECIAL CAR FOR TRANSPORTING TORPEDO BOATS.

the most prominent parts of the boat and its hull. This contour model, shown in fig 9, consists of a section of planks fixed at the back end of a brake van, and boarded by a double fringe of lead stems having a length of from 2 in. to 4 in. The contact of the walls of the permanent structure or obstacles of that kind would show themselves by the breaking of the model or the bending of the shoulder or angle stems. These tests were repeated two or three times, and favorable results were obtained therefrom. The changes that had to be ment. It agreed to have the train accompanied by competent representatives, who should verify the load along the route and readjust it whenever the necessity should arise. The transportation was made by a special train. The running speed was limited to 15½ miles per hour on a straight line and 18¾ miles at most in case of delay. The passings at stations were to be made only at a foot pace. The expense of transportation was fixed at 5 cents per ton per mile plus 8 cents per ton for the right of way, with a minimum of $1 per mile

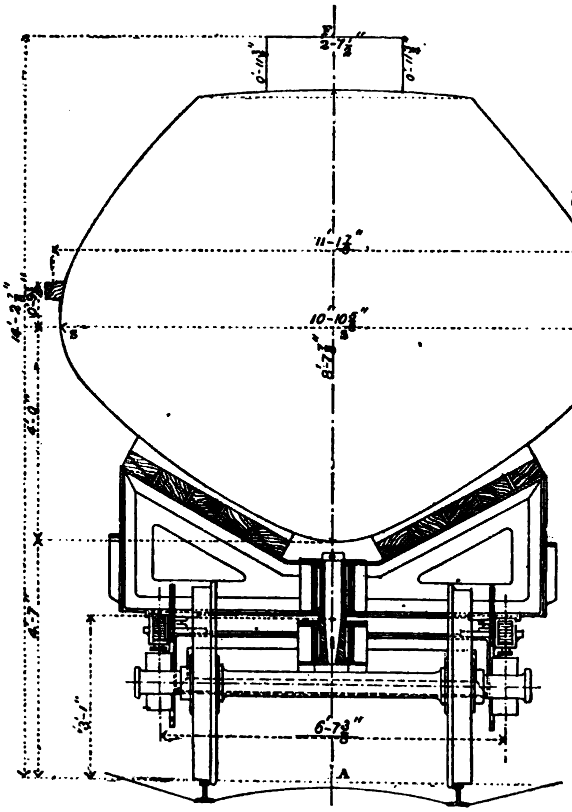


Fig. 4.

CROSS-SECTION OF CRADLE FOR CARRYING TORPEDO BOAT.

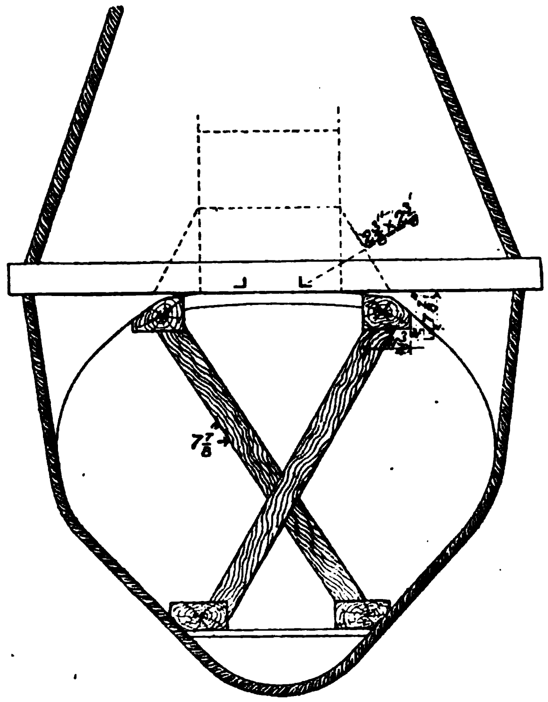
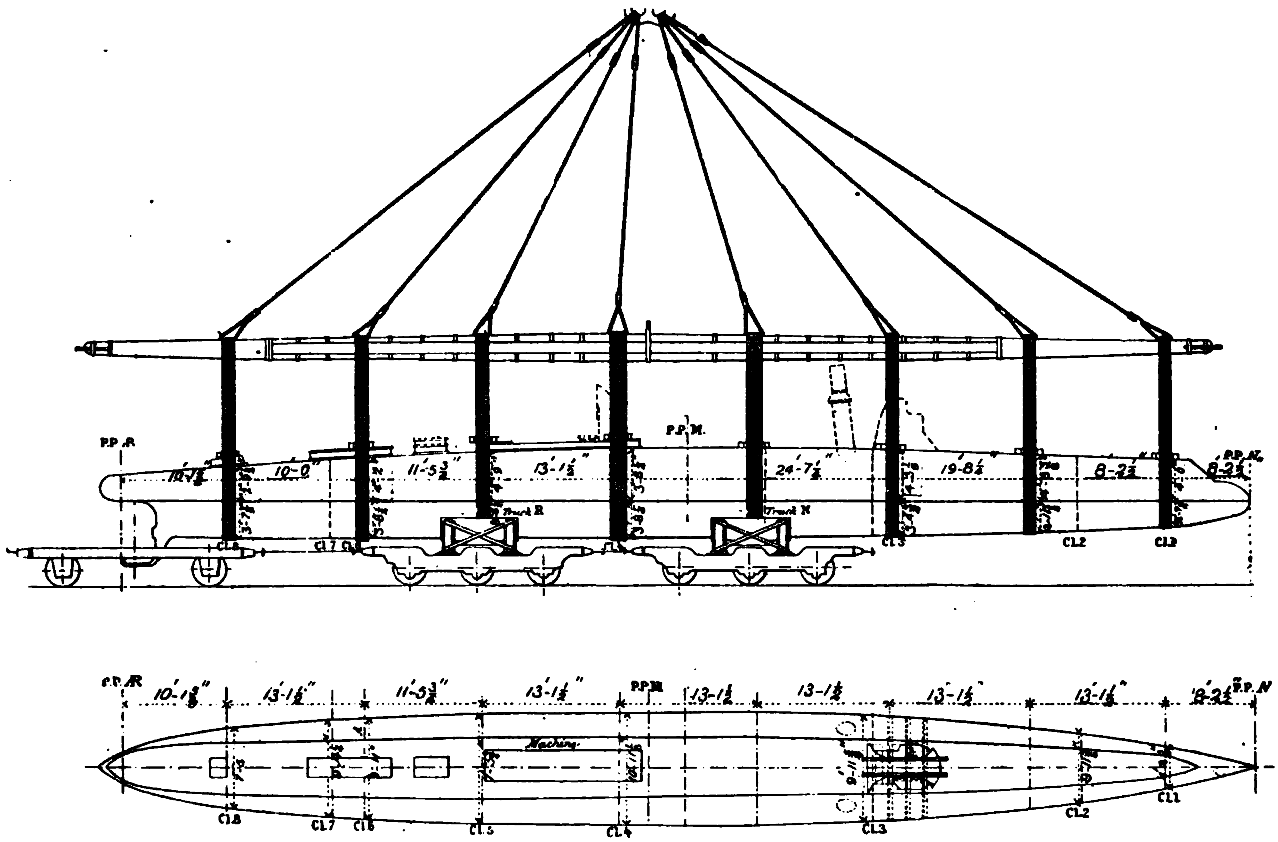


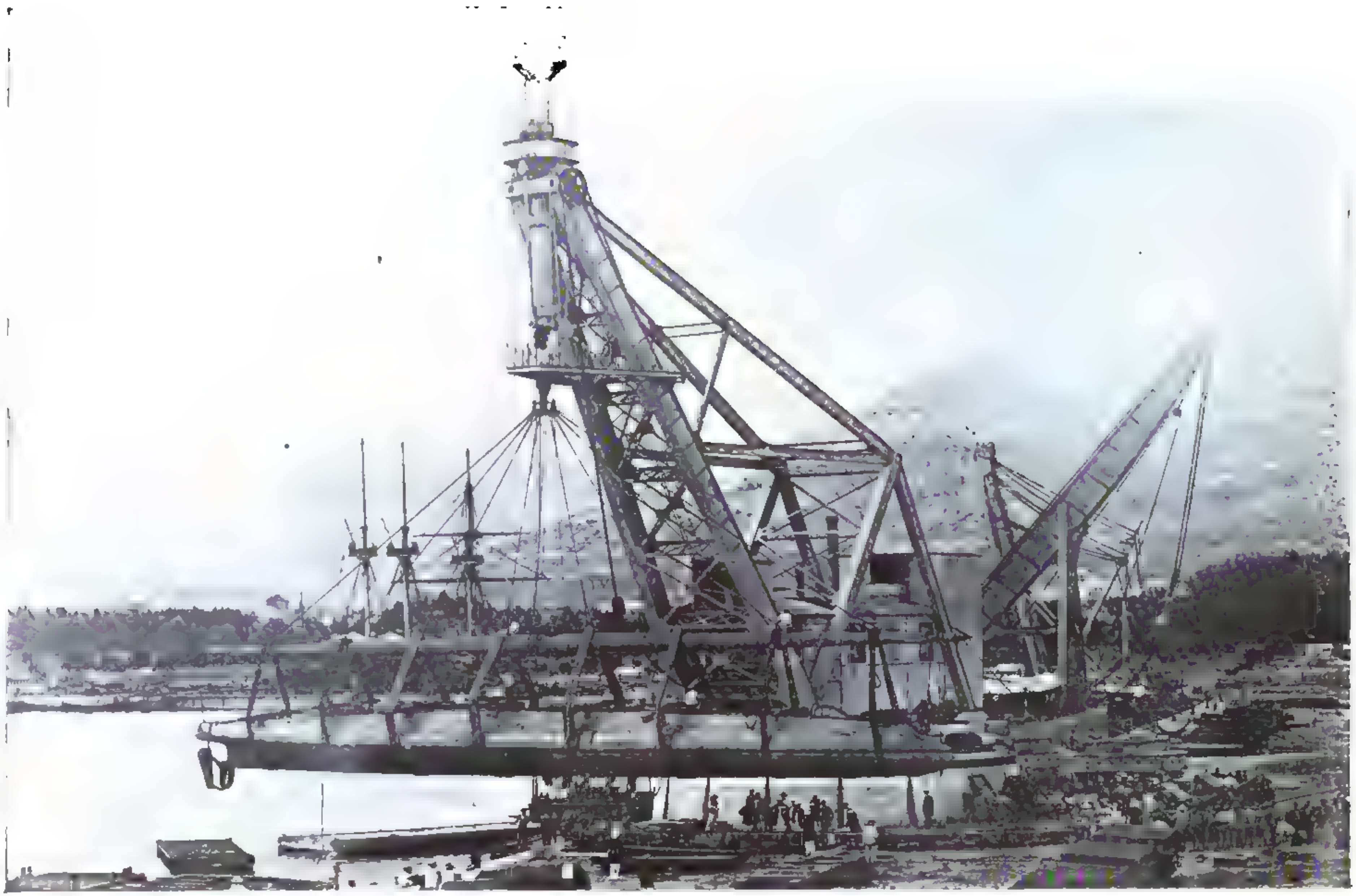
Fig. 7.

ST. ANDREW'S CROSS USED FOR STAYING INTERIOR OF TORPEDO BOAT WHILE IN SLINGS.



Figs. 5 and 6.

METHOD OF ADJUSTING SLINGS ABOUT TORPEDO BOAT FOR HOISTING AND PLACING ON CAR.



HYDRAULIC CRANE IN NAVY YARD AT TOULON, USED FOR LIFTING TORPEDO BOAT FROM THE WATER AND PLACING ON TRUCKS

run by the special train. These different conditions having been agreed upon by the railway companies, the Minister of Marine made a contract with the Creusot Company for the manufacture of the trucks. The material ordered consisted of two bogie trucks of three axles each, with two cradles or racks for carrying the torpedo boat to be placed upon them. A special car was made to carry the sternpost of the boat with two flexible hauling chains. The Creusot engineers, under the direction of the Navy Department, made a careful examination as to the best method of constructing these trucks. It was originally intended that they should be built of wood and iron. The wooden cradles were to turn in arcs of a circle made of iron resting upon the bolster of a truck, just as long timbers are now carried on cars. The trucks and cradles as finally built were made entirely of metal, as shown in figs. 1 to 4; the angle which the cradle could describe was very small, and iron was replaced by four elliptical supports made of bronze, including a portion of the same arcs of a circle; the cradle rested upon a bogie by spherical bearing of the same metal sliding upon the oiled surfaces of these supports. The principle of dropping the side beams of the truck down between the axles in order to lessen the height of the torpedo boat from the rail was employed. Tender-axles were used for the wheels. The bearings of outside axles were furnished with radial boxes on the inclined plane principally to facilitate the passage around curves of short radius. The torpedo boat rested upon a cradle through wooden liners packed with oiled waste. The trucks were made to carry 20 tons each, and were delivered and tested under such a load, but later, in consequence of the examination into the subject by the Paris, Lyons & Mediterranean Company, it was thought that they could carry the 25 tons very readily.

It was found that in order to transport the torpedo boat, it was very essential that the sternpost, which carries the rudder and surrounds the screw, should be carefully supported, as it could not be removed without injuring the strength of the vessel. The result of this was that it was found necessary to build a special car composed of a framework carried on wheels and across which the sternpost could move on curves. The special car, an engraving of which is shown in figs. 1 to 4, was designed at Creusot. The plans for this material being approved by the Minister of Marine, after having been subjected to the approval of the engineers of the department, were sent to me. The expense of the material was $6,137 and is the property of the State, and will be used for any transportations of this kind that may be required in the future.

The engineers of the Navy Department also investigated as to the best means of loading torpedo boats upon this new device. They agreed upon the me hod shown in figs. 10 and 12, which was used at Toulon. The boat, strengthened on the inside by a St. Andrew's cross, was surrounded by eight slings or bands, all of ropes, the upper part of which passed over a long boom parallel to the center line of the torpedo boat. This boom was fastened by eight balancing lines of wire rope to the hook of an hydraulic crane. The horizontal stays placed above the boat at each sling prevented the two sides from crowding in and crushing the boat. The same system was used at Cherbourg for lowering it into the water, but the number of suspension lines was reduced to six. The Navy Department has the necessary cranes at Cherbourg and Toulon for raising a small boat, and all of the other necessary arrangements for lifting.

In the April issue of the The American Engineer and Railroad Journal a description and engraving of the 160-ton crane, which is in use at Her Majesty's Dockyard, at Chatham, England, was published. The crane which was used for hoisting the torpedo boat out of the water at Toulon and placing it on the trucks has the same capacity, and has been in operation at the arsenal of Toulon for the past ten years. There is also a similar one at Brest, but of a still larger capacity. This crane has, as we have already said, a capacity of 160 tons, an outline of which is given in a small engraving, and its general appearance is clearly shown on the full-page reproduction from a photograph taken at the time when it was lifting the torpedo boat from the water. It is built upon the quay of Missiessy, where it handles enormous weights in the form of the heavy guns that are presented for installation in the batteries of modern vessels of war. This crane was built by Bon & Luestromont, and, like the one at Chatham, has a peculiar characteristic of using water under pressure instead of a chain as a means of transmitting power from the steam-engine to the hook intended to lift the weight.

It is composed of an iron skeleton forming an articulated system, and composed of a jib made of two backstays, tie beams and braces which are required to hold the jib, and a horizontal platform upon which the balancing counterweight, the boiler and engines are placed.

The crane turns about an iron pivot fastened to a cast-iron plate embedded in the masonry, which is, in turn, supported by 250 piles. It turns on a circle of loose rollers, which in turn roll over a circular track. The loads are lifted directly by a piston, which moves in a vertical cylinder located at the head of the jib. The piston is driven by means of water under pressure of 1,400 lbs. per square inch, which is furnished by a 24 H.P. steam-engine coupled directly to three pumps and fed by a boiler working under a pressure of 85 lbs. per square inch, having 323 sq. ft. of heating surface. The delivery pipes from the pumps are in communication with an accumulator formed of a cylinder, in which a piston carrying a charging load moves, and which is so adjusted that the piston rises when the water pressure reaches 1,400 lbs. per square inch. Before reaching the upper limit of its stroke, the accumulator automatically moves a tappet which closes the steam-pipe to the engine cylinders. The crane is also provided with a turning pivot and a hauling capstan moved by a small hydraulic engine, friction clutches permitting it to work in every direction. Finally, weights of less than 22,050 lbs. are raised by means of a chain passing over a pulley fixed at the head of the jib and driven by a special hydraulic piston. This piston is so geared that a stroke of 3.28 ft. produces a lift of 19.68 ft. at the hook. The expense of the crane was about $39,900, of which $6,650 were for the foundation. This apparatus has always worked perfectly since it was first put in service, and is considered a worthy example of French engineering construction.

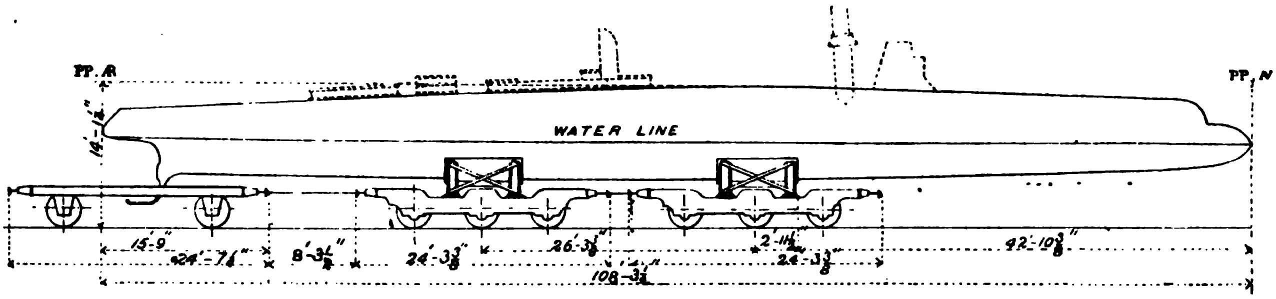


Fig. 8.

OUTLINE OF TORPEDO BOAT IN POSITION ON TRUCKS.

Everything being ready, the Minister of Marine chose a torpedo boat of 108 ft. 3 in. in length for the trial. It being at Toulon, it was decided that the transportation should take place in the opposite direction—that is to say, from Toulon to Cherbourg. The torpedo boat No. 71, of 108 ft. 3 in., was built in Havre, by Normand, and was under the command of a Lieutenant Bachmes. The material built at Creusot was sent to Toulon. The setting upon the trucks was accomplished without any difficulty. The beam, hung from a hydraulic crane, was lowered to a point over the boat. Each sling was composed of a rope passing eight times around the boom, being carried under the vessel by two divers. These slings were almost exactly like rigid connections, and the lifting of the boat on to the trucks was accomplished without any difficulty. Finally, to make sure that the overhang should not bend, and, in any case, in order to determine the limits of deformation which might be produced, the boat was left for 40 hours simply resting in its cradles and without any other support. It was found at the end of that time that the boat showed no signs of straining. The Paris, Lyons & Mediterranean Company having verified the load, remarked that the center of gravity of the boat not being in the center of its length was therefore not an equal distance from the two

trucks, so that the weight carried by each of them was not the same. One of the trucks carried 11 tons, the other 27 tons, which made 12.3 tons per axle for this truck, including its own weight and that of the cradle. To equalize this load and raise that of one of the trucks to 20 tons, the maximum calculated by the Creusot Company for the side beams, it was necessary to shift the torpedo boat 5 ft. 10¼ in. ahead. The overhang at the front end then became 42 ft. 10¼ in. The change in the direction of the route compelled the Paris, Lyons & Mediterranean Company to run the contour car over the line which the torpedo boat was to traverse. This second experiment merely confirmed the results which had already been obtained. Finally the Navy Department was compelled to enlarge the entrance gate to the Cherbourg arsenal, and to pierce the interior wall and to modify the track beyond this wall in order to prepare for the passage of a curve of 459 ft. radius. The first movement was made from the arsenal to the Polytechnic School of Toulon. The curve of small radius surrounding the basin was passed successfully, and the return by backing was made without any difficulty.

Then a trip was made as a preliminary test between Toulon and La Ciotat, which was about 18¾ miles distant. The train ran first from the arsenal to Seyne, made a turn about the dock, running along curves of 492 ft. radius, and then ran toward La Ciotat and came back without any difficulty into Toulon. The carrying of the torpedo boat was perfect in every particular, and the oscillations to which it was subjected did not cause the slightest trouble. One of the axles of the truck heated considerably on the run, but this very frequently occurs when new material is used for the first time under a very heavy load. The special train passed another train while running without any trouble. The test was perfectly successful from a technical standpoint. Finally a serious accident occurred on leaving the arsenal at La Seyne. Inspector Bonnemain, who was on the torpedo boat, was thrown upon the track by telegraph wires, and had his foot crushed by the wheels of one of the cars, so that an amputation of the leg was necessary.

The route to be followed from Toulon to Cherbourg had been laid down by the railroad companies, who had agreed to the running of the train over their lines. The line chosen ran by way of Marseilles, Tarascon, Remoulin, Pont-Saint-Esprit, Peyraud, Firminy, Montbrison, Thiers and Moulins, on the

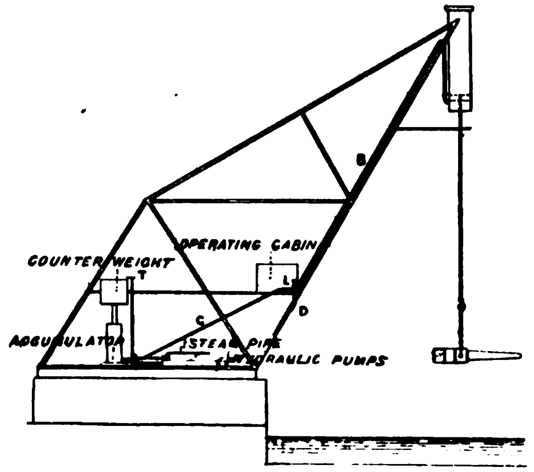


Fig. 11.

OUTLINE DIAGRAM OF CRANE.

Paris, Lyons & Mediterranean Line; by way of Montlucon, Vierzon, Tours, Le Mans over the Orleans Railway; and Mezidon and Caen on the Western Road. The total distance between is 848 miles. The running of the train at the rate of 15½ miles an hour at the maximum was calculated under two hypotheses; the first took it for granted that there would be no stop which would necessitate a night service under certain parts of the road. The start from Toulon was fixed at 6.30 in the morning of the first day, and the arrival at Cherbourg would have been at 7.45 on the evening of the third day, the duration of the run being 61 hours, 51 minutes. The second schedule was laid out with the idea that the train should stop

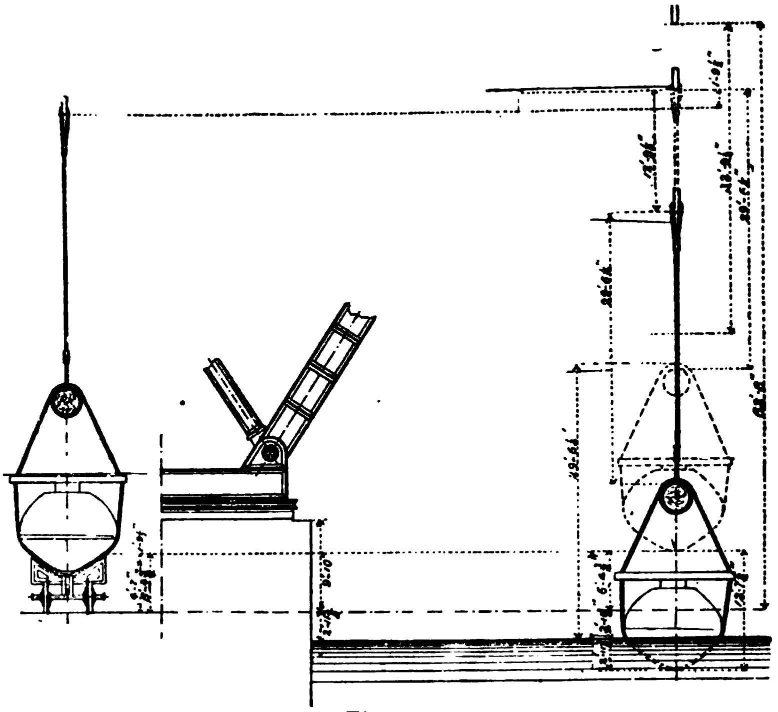


Fig. 10.

DIAGRAM SHOWING LIFT OF CRANE REQUIRED FOR TORPEDO BOAT.

every evening and should not travel at night. The start from Toulon was also placed at 6.30 on the morning of the first day, but the arrival at Cherbourg would not occur until 7.54 on the evening of the seventh day, after a trip of 157 hours and 24 minutes. Although the duration of the trip was lengthened by 96 hours, 9 minutes, or four days, the Navy Department preferred the second itinerary, on account of the care which would have been necessary for the first trial, as well as for the watchfulness which would have been necessarily incurred along the line and the saving of night work. It was understood definitely with all of the companies that the passenger service on all of their roads should not be modified, and that the special-trip train should await their passage, but that, on the other hand, the freight train should wait for it.

A new verification of permanent structures along the line from Mans to Mezidon caused the Western Company to ask that the guard rails and engine-room projections should be removed from the torpedo boat. The lead stems forming the fringe of the contour car had touched a tunnel, and 14 permanent structures and the planking showed that the projections of the engine would have scraped the posts of six others and been broken. The lateral projections had touched certain loaded cars and even the lanterns of trains that had been passed. The work demanded was done, but it caused a great deal of difficulty, especially when it came to the matter of the angle irons holding the guard-rails; these angle irons were riveted to the main scantlings on the inside of the boat, and to detach them involved considerable work, especially in the water-tight partitions. Finally, at Toulon, a loading model with a contour of planks of the same kind as that used upon the railroads was placed in the arsenal, and it permitted the train to pass without any accident.

The final composition of the train included an engine and tender, a brake van for the conductor, a tool car, a passenger car, and a car for assistants; two platform cars without any side bars served as sustaining cars under the front end of the boat. They were attached to the two trucks and to the special car built for the sternpost. The latter was followed by a second tool car, and a brake van was used for a lookout. From the car occupied by the assistants all the movements of the torpedo boat were watched, and especially the oscillations of its overhang. One of the tool cars contained the armament

of the boat, and the other the conning tower, smoke stacks, and those parts of the boat which had been taken down for transportation. Everything being thus prepared, the attempt at transportation having been made to La Ciotat, the train left Toulon for Cherbourg at 22 minutes past 6 in the morning. During the trip each company sent a section man with the

Fig. 9.

CONTOUR CAR FOR TESTING CLEARANCES OF PERMANENT STRUCTURES.

train, as well as a general inspector and a representative from the locomotive department. No accident occurred on the route, although the axles of some of the trucks heated, and one especially so, but not to such a degree as to hinder the transportation nor to cause any delay in the running of the train. The heated axle was cooled by putting a mixture of oil and flour of sulphur in the oil-box. The total amount of the oscillations of the front end of the overhang did not exceed from 4 in. to 6 in. Between Tours and Le Mans the maintenance department of the Orleans Railway lowered the track considerably, without which this work would have incurred further difficulties. Also some disks and other permanent structures had been removed as the necessities have indicated.

Starting from Le Mans, the two lead stems which corresponded to the projections of the angle irons holding the guard-rail of the torpedo boat passed everything without touching it. The wood of these guard-rails having been taken off for the trip, it became important to demonstrate the possibility of maintaining the angle irons in place without taking them down, as the replacing them would necessarily involve considerable work. It was also seen that the track would admit of a greater breadth than that of the torpedo boat of 108 ft. 4 in. in length. Between Dissay and Le Mans and between Carentan and Cherbourg the speed was increased without any trouble to 21¾, and even 25 miles per hour. During the run the train stopped at Pont-Saint-Esprit, Firminy, Moulins, Saint-Armand, Tours and Argentan. The torpedo boat had then passed the Auvergne Mountains. From all parts the people collected along the line of the road to see a war vessel, and one of such recent invention, passing over France on a railway. Those who took part in the trip will never forget the interest and the curiosity which everywhere centered about this strange object. The torpedo-boat train reached the Cherbourg station on September 2 at 7.50 P.M.

In the morning of September 3 the train, which had been standing in a station on a special side track, was run into the Cherbourg arsenal, where everything was ready for setting the vessel in the water, but the rivet holes of the guard-rails did not permit this work to be done at once, and it was here found that the whole had been subjected to no strain and had incurred no alteration during the trip.

Immediate attention was then paid to the rearmament, but the riveting and relocation of the guard-rails required some time, and the vessel was not in the water again till September 12. This was merely a repetition of the operation of setting it on the trucks. The commission which had charge of the torpedo boats and took control of the test stated that it had lost nothing in speed, and that its hull, boiler, engines, and military apparatus had suffered in no way by this transportation over the railroad. The torpedoes alone were slightly out of order, but this disadvantage was not a serious one, and the boat on its arrival was equipped with torpedoes that were already prepared. It must be remarked that those which had come from Toulon were in boxes placed in one of the brake vans of the train, and their disarrangement did not at all depend on the movements of the boat during the trip.

The expense of work preparatory to transportations of this kind has been placed at $114 per boat at the starting-point and at the point of arrival. In addition to this, $2,578.5 were paid to the railway companies. The amount which they received was just about equal to their disbursements. The time of preparation of the boat for transportation and rearmament was about 20 days, on account of the difficulties offered by taking down of the engine-room projections, and especially the angle irons holding the guard-rail. It is possible to diminish this delay very considerably by keeping the angle irons, the guard-rails, and the engine-room projections in place, and making a few modifications in overhead work, such as the stacks, the fastenings of the conning tower, and other deck projections. Lieutenant Baehmes estimates that this work can be easily reduced to 8½ days, four of which can be occupied in the trip. The itinerary laid down by the railway companies showed that by running at night with a speed of only 15½ miles per hour, the trip could be made in 61 hours, or 2½ days. Thus at the end of 7 days the vessel, from being ready to go to sea at Toulon, would be ready to leave Cherbourg for its new destination.

The trial has therefore been very successful, and it has been demonstrated that it is possible to carry torpedo boats having a length of from 108 ft. to 130 ft., over a run of 848 miles without any trouble. Their transportation from Toulon to Cherbourg, including disarmament and rearmament, could be accomplished in 7 days, while the voyage by sea would require 20 days. In the latter they encountered all kinds of dangers, especially those that were shown to exist near Cherbourg on March 22, 1889, or those which involved the loss of *L'Avant Garde* on the shores of Portugal in February, 1890. Torpedo boats which have made the passage by way of Gibraltar have reached port with their hull and boilers strained, requiring extensive repairs; whereas those which had come over by rail would be ready to go into service at once. In case of war the trip from the Mediterranean to the ocean or to the English Channel and inversely could be made rapidly and with absolute security. Finally, in the same instance, a torpedo boat would be delivered at any point reached by railways where a track of standard gauge has connections, and the Navy Department could prepare in all ports, which it would consider advisable, inclined planes or other means for placing the vessel in the water or for loading it upon the trucks. These are the results which have been demonstrated by the trial transportation of a torpedo boat from Toulon to Cherbourg.

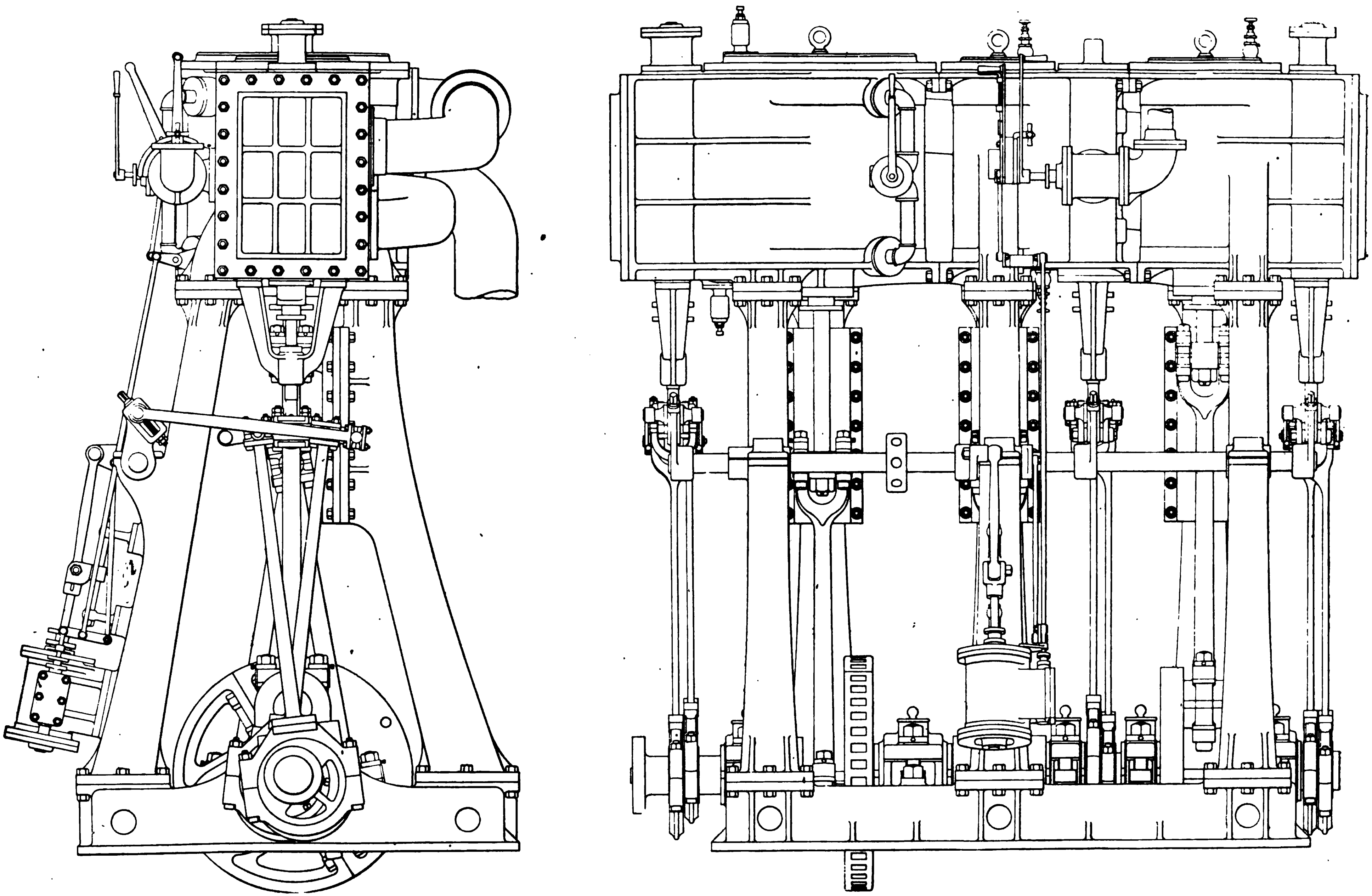
TRIPLE-EXPANSION ENGINE FOR TUG "W. G. WILMOT."

The engine published in this issue was built by F. W. Wheeler & Co., of West Bay City, Mich , for a steel tug named in honor of her owner, *W. G. Wilmot*, of New Orleans, La. The general dimensions of the vessel are as follows:

Length over all	110 ft. 6 in.
Length between perpendiculars	99 " 6 "
Beam, molded	23 " 0 "
Depth, molded	12 " 6 "
Draft of water	11 " 0 "

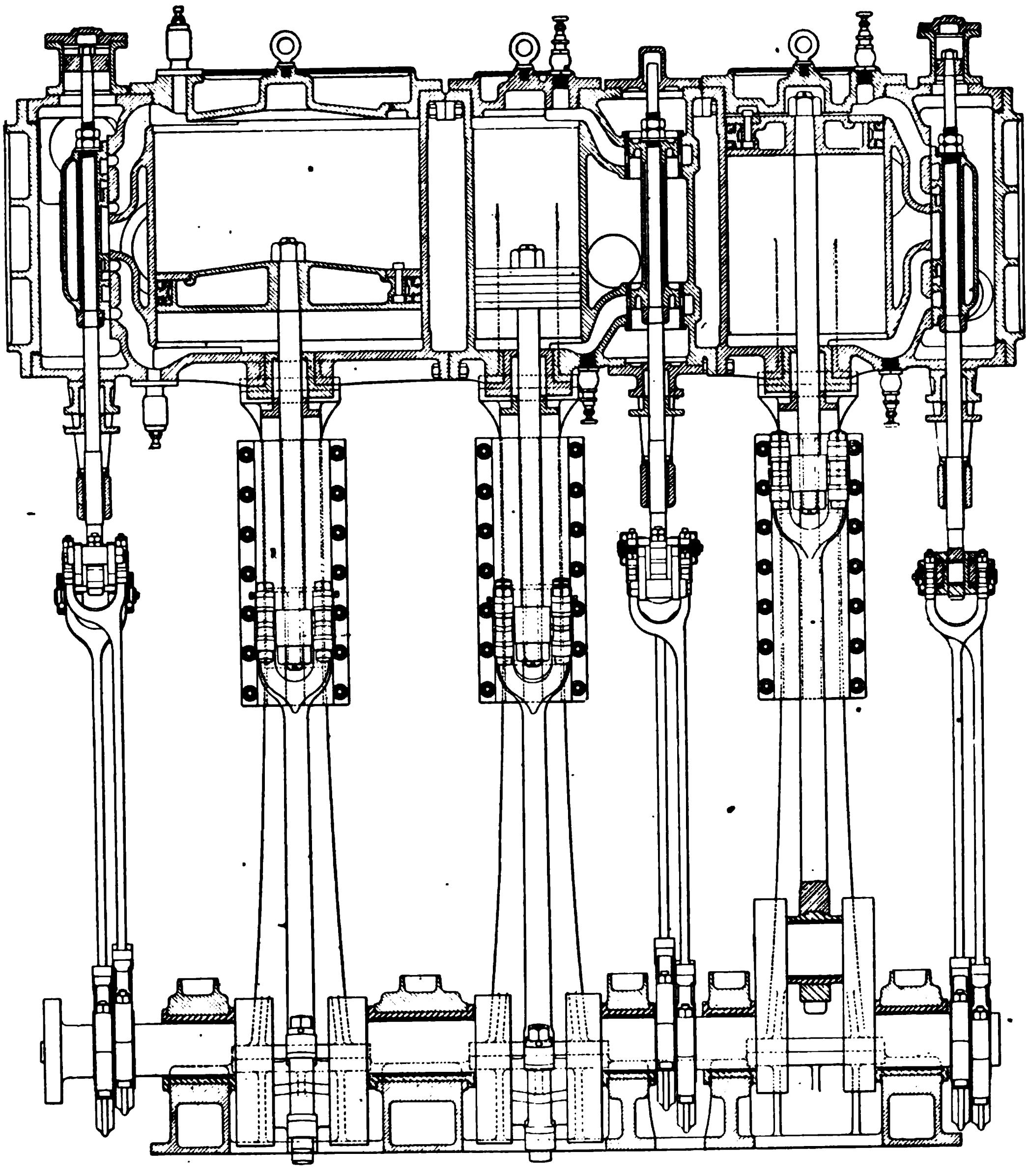
The propelling machinery consists of an inverted, direct-acting, surface-condensing, triple-expansion engine, with cylinders 16 in., 24 in., and 40 in. diameter, and a stroke of 28 in., driving a right-handed screw propeller 9 ft. 6 in. in diameter, with a mean pitch of 12 ft. 6 in. The cylinders are placed with the high pressure in the middle, the intermediate forward, and the low pressure aft, this being the sequence of cylinders generally adopted by the majority of engine-builders on the lakes.

Each cylinder is fitted with relief valves, top and bottom, and the low-pressure cylinder is provided with a 2½-in. starting valve. All steam-ports and passages are calculated for a



END AND SIDE ELEVATIONS OF TRIPLE-EXPANSION ENGINES FOR TUG "W. G. WILMOT," BUILT BY F. W. WHEELER & CO., WEST BAY CITY, MICH.

piston speed of 650 ft. per minute, with a flow of steam of 9,000 ft. per minute for steam passages and 6,000 ft. per minute for exhaust. The ports in the high-pressure cylinder are 1⅞ in. deep and 13 in. wide. The intermediate-pressure cylinder has two 1½-in. × 19 in. ports, and the low pressure cylinder has two 1⅝-in. × 36 in. wide ports. The main steam-pipe is of copper 5 in. inside diameter, the intermediate receiver pipe is 8 in., and the low-pressure receiver-pipe is 10½ in. in diameter, the exhaust-pipe leading to condenser being 12 in. in diameter. The throttle-valve is of the balanced type, and fitted with a suitable relief-valve, so as to work free and easy. The high-pressure cylinder is provided with valve-chest liners of hard, close-grained cast iron with diagonal bridges and ports 1½ in. deep. The piston-valve is solid, 7½ in. diameter, and fitted perfectly steam-tight in liners; lap on top is 1⅛ in. and 1¼ in. on bottom; no inside laps. The intermediate-pressure and low-pressure cylinders are fitted with common double-ported slide-valves, perfectly balanced by cylinders and balance pistons of 4½ in. and 7 in. diameter respectively on top of steam chests. The intermediate-pressure valve has a steam lap of $1\frac{5}{16}$ in. on top and $1\frac{3}{16}$ in. on bottom, and the low-pressure valve has $1\frac{5}{16}$ in. lap on top and $1\frac{1}{16}$ in. on bottom. All valves have a travel of 4½ in. and are worked direct by the Stevenson double-bar link-motion provided with adjustable cut-off arrangement. Steam is cut off at about .7 of stroke in all cylinders when in full gear. All valve-stems are of best machinery steel and 2½ in. diameter. The engine is provided with steam reversing gear, having a cylinder 10 in. diameter and 12 in. stroke operated by a differential valve-motion from the engineer's platform. The pistons are of cast iron 6 in. deep, and are fitted with the usual lake style of self-setting spring rings. The piston-rods are of best machinery steel 3½ in. in diameter, secured to cross heads and pistons by tapered ends and nuts. The cross-heads are of wrought iron with gudgeons and slippers forged on. The slippers are provided with brass jibs 8½ in. wide and 12 in. long. The connecting-rods are of wrought iron 6 ft. between centers, having the upper ends forked to span the cross-head jaws, which are 3½ in. long and 3½ in. diameter. The upper ends are turned to a diameter of 3⅝ in. and 4 in. at the lower ends. All connecting-rod bolts are of steel 1½ in. diameter at the upper ends and 2 in. at the lower ends. The crank pin brasses and all main journals are lined with Magnolia anti-friction metal strips. The cylinders and valve-chests are covered with magnesia covering and lagged with highly polished birch. They are supported by six cast-iron columns, the port columns being provided with large bearing surfaces and water-jackets for slides. Through-bolts are used wherever practical throughout the whole engine. The bed-plate is the box type cast in one piece, having five main journals, each journal having two 2½ in. holding-down bolts and cast-iron caps. The crank-shaft is made of best wrought iron of the built-up type 8 in. in diameter. The thicknesses of crank arms are 4⅝ in. for intermediate pressure, 5½ in. for high pressure, and 5⅝ in. for low pressure, with a common width of 15½ in. The crank-pins are all 8 in. diameter and 8½ in. long. The cranks are placed 120° apart, with



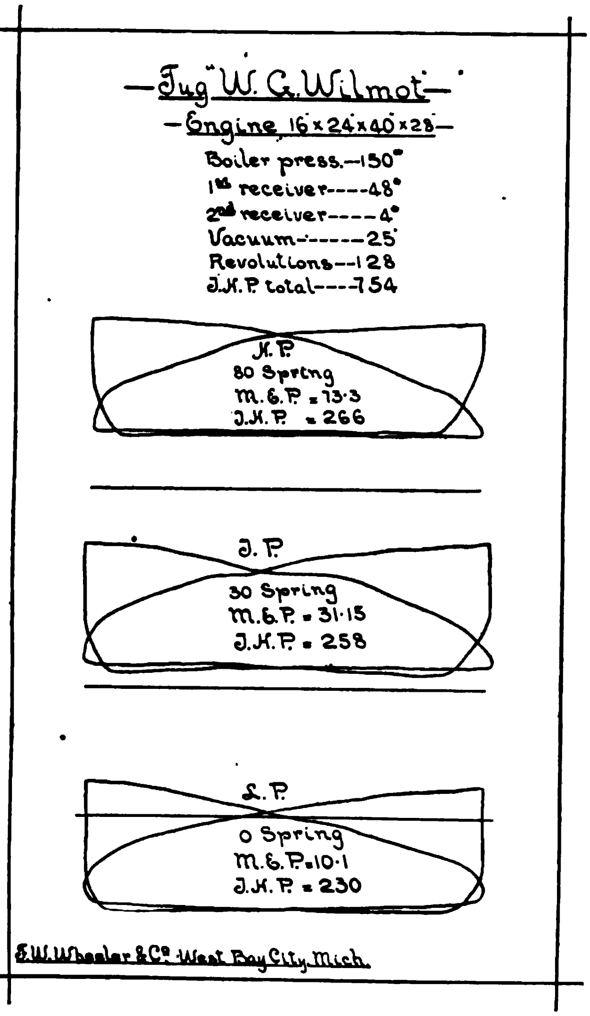
LONGITUDINAL SECTION OF TRIPLE-EXPANSION ENGINE FOR TUG "W. G. WILMOT."

the low pressure leading high pressure. The thrust-shaft is 8 in. diameter, having the collars forged on, 14 in. diameter and 2½ in. thick. The thrust bearing is of the horseshoe type, with three cast-iron collars lined with graphite metal and adjustable by means of strol-bolts and brass nuts. It is designed for a thrust of 50 lbs. per square inch, and provided with a line bearing 9 in. wide to support the thrust-shaft. A similar line-bearing supports the after end of thrust-shaft. The stern tube is 10 ft. long, made of cast iron, with internal bushings forward and aft. The forward bushing is of brass lined with lignum vitæ, and the after bushing is 34 in. long and made of hard cast iron in halves, so as to be easily renewed when worn. The propeller-shaft is 8 in. diameter and 8⅝ in. at bushings. Wrought-iron bands are shrunk on propeller-shaft at after-bearing to provide for the great wearing caused by

the extreme amount of sand and clay found in the Mississippi River water. Experience has shown that cast-iron stern bearings are most suitable for service in these waters.

Steam is furnished by a cylindrical return tubular boiler 12 ft. 6 in. in diameter and 12 ft. 6 in. long, designed for a working pressure of 160 lbs. per square inch. The three furnaces are 40 in. inside diameter and 8 ft. long, giving a grate surface of 68 sq. ft., and the boiler has 218 3¼ in. charcoal iron tubes 8 ft 6 in. long, with a total heating surface of 2,100 sq. ft.

All pumps are independent, and the condenser is of the Wheeler Admiralty Surface Condenser type, with combined



air and circulating pumps. Diameter of steam cylinder, 12 in.; diameter of air cylinder, 14 in.; diameter of water cylinder, 14 in., with a common stroke of 12 in. Cooling surface in condenser is 1,100 sq ft. The feed-water passes from the hot well through a feed-water filter in four compartments filled with hay and charcoal to the feed-pump, and is discharged through a feed-water heater into the boiler. The exhaust steam from all pumps passes through this heater, which is 24 in. diameter and 10 ft. long, and contains 70 1¼ in. brass tubes.

The maximum power developed by the engine under 160 lbs. of steam and when making 148 revolutions per minute is 850 indicated H.P., the vessel making 16 statute miles per hour. The indicator cards published herewith were taken when the engine was working 128 revolutions per minute under ordinary conditions, with 150 lbs. of steam and 25 in. vacuum. The engine was built from designs by Sven Anderson, Mechanical Engineer with F. W. Wheeler & Co.

The Dry Dock Iron Company, of Bay City, Mich., are now building one of their patent sectional cast-steel screw-propeller wheels for the *W. G. Wilmot*. The advantages claimed by this type of propeller are a saving in weight of about 15 per cent. over the ordinary sectional cast-iron wheels, less resistance caused by a screw-shaped hub, and greater strength gained by using the best cast steel made. Especially is the latter a desirable feature for lake vessels and river tugs striking snags and logs very frequently. As will be seen from the engraving, the blades are dovetailed in the hub and carefully fitted and fastened by means of steel keys. The new screw ferry steamer *Pleasure*, now building for the Detroit, Belle Isle & Windsor Ferry Company, is fitted with a 10-ft. wheel of this type, and the results will be looked for with great interest.

LIQUID FUELS.

Mr. G. Stockfleth, an engineering expert of the Noble Petroleum Production Company, recently read a paper on Liquid Fuels before an English technical society. The following is an abstract from it:

"The use of liquid fuel is by no means of recent date; it has for many years been pretty general in Russia, and the question cannot any more be considered as a problem which has to pass through its experimental stages. Before going further into the subject, it may be well to define which liquids can best be used as fuel. A good many oils might enter the list were it not for some indispensable requirements, such as cheapness, absence of danger, capability for developing heat and undergoing complete combustion, without producing unpleasant smells, smoke, and dangerous and unhealthy gases, which conditions practically reduce the number to the oils derived from coal and from crude petroleum. The first-named (oil derived from coal) is, however, not produced in sufficient quantities for even a limited consumption, and would be far too expensive to manufacture solely for fuel purposes. It is, therefore, to crude petroleum that we must turn for obtaining a suitable oil.

"Crude petroleum consists almost entirely of a mixture of a great number of hydrocarbons differing in boiling point and density, and, by being submitted to distillation, it gives a series of hydrocarbons known as gasoline, benzoline, kerosene, etc. It is not necessary here to give a detailed description of these different products. Suffice it to say that the first distillate of crude petroleum, which evaporates at a low temperature, is the most inflammable, and gradually, as the temperature is raised, the less dangerous oils are distilled, until the temperature in the stills reaches 300° C. to 320° C.; at this point the distillate is called kerosene, and the residue (which in Russian is called astatki) forms the oil which so admirably answers the conditions for a good liquid fuel. It contains all the heavy hydrocarbons capable of creating heat, and the high temperature to which it has been exposed having freed it from all dangerous volatile liquids, guarantees its complete safety; a match or any other naked light is immediately extinguished when plunged into it. In order to make it burn it requires special treatment, about which more shall be said presently. As astatki presents no danger whatever, it is in Baku stored in large open excavations in the ground, containing up to 5,000,000 poods each, equal to more than 100,000 tons. In some of the distilleries astatki is used as fuel under one still immediately after having been let out of another, which shows that even at a high temperature it can be handled with safety. The Russian crude petroleum gives about 35 per cent. benzoline, gasoline, and kerosene; the remaining 65 per cent. is used for the manufacture of lubricating oils and mostly as fuel. To give an idea of the extent to which it is used in Russia for locomotive, steamship, and even stationary boilers, it may be mentioned that the transport of astatki from Baku to the Caspian seaports and Astrakan, amounted, in 1892, to 107,361,435 poods, equal to about 3,000,000 tons; and, in addition to this, some 250,000 tons were shipped from Batoum. The statistics for 1893 are not yet available for reference, but will probably show an increase.

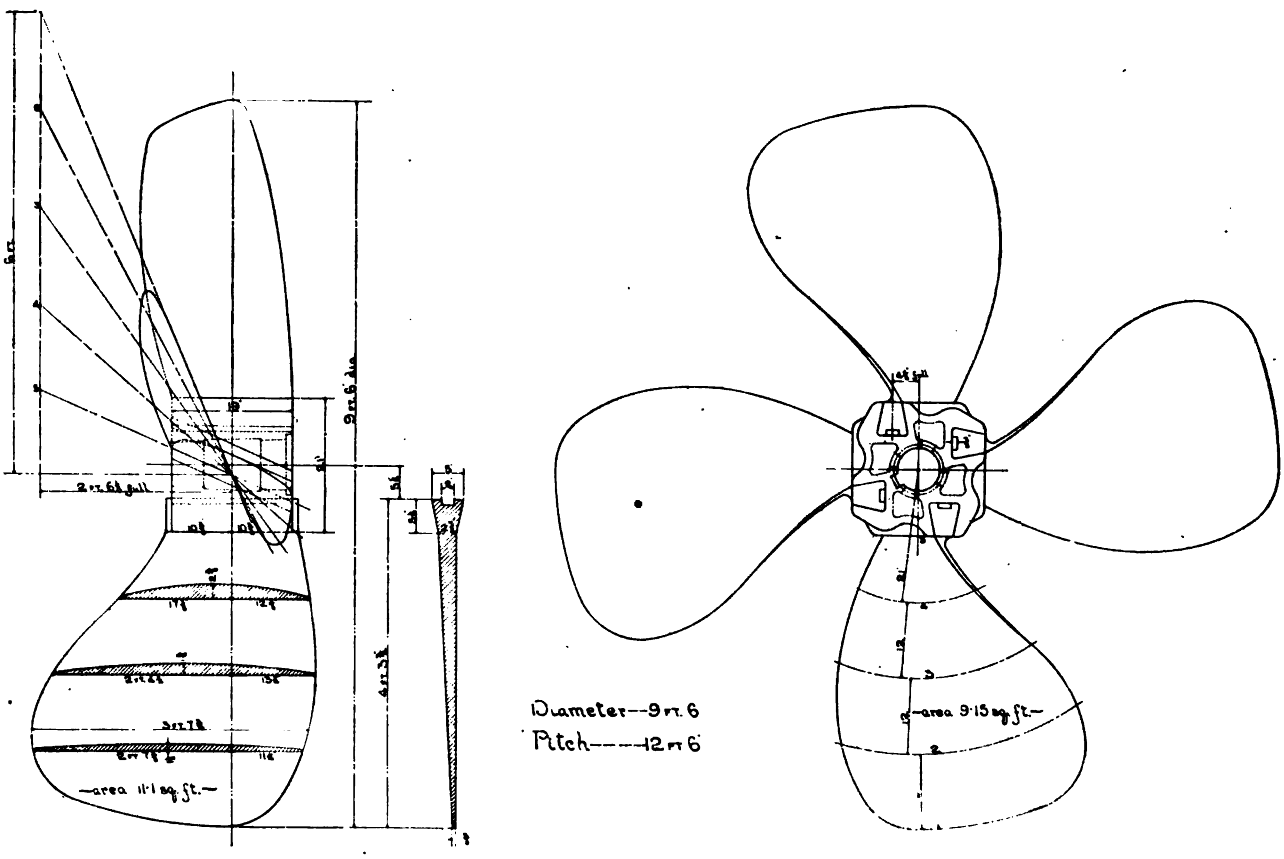
"For boiler and distilling purposes it is necessary to create a larger and more powerful flame, and steam is used for forming it into a spray which is easily ignited, and then burns fiercely. Many injectors or pulverizators in Russia, called fasunkas, have been constructed and patented, but it has been found that the most primitively constructed pulverizators answer as well as the more complicated kinds. The apparatus used under the stills consists simply of two ½-in. pipes, one leading the oil from a tank, the other steam from a boiler. The ends of the pipes are flattened by a blow of a hammer, and then tied together with a piece of wire; the steam jet catches the outflowing oil, and forms the spray. It is well to keep the oil a little warm to facilitate its passage in the pipes, through which it descends by gravitation. This pulverizator gives entire satisfaction; the flame is powerful and bright, and not a drop of oil is wasted when once the flow has been regulated. No smoke or flame ascends the chimney—which,

by the way, can be very short—as the steam jet itself creates sufficient draft. A somewhat neater appearance can be given to the injector when the oil-pipe is arranged inside the steam-pipe. and provided with a cast-iron or brass nozzle, which can be shaped to give the flame any desired form. As far back as 1880 I had occasion to make, on behalf of Messrs. Nobel Brothers, in St. Petersburg, some experiments with oil firing before a committee of the Russian Admiralty.

"Experiments have been made with compressed air for spraying the oil, but the results have not materially differed from those obtained with steam. Air must, of course, in any case, have access to the flame, and openings on the front of the flue must be provided for its admittance. In most cases the hole in the furnace door through which the nozzle of the pulverizator is introduced, is sufficient for letting in the quantity necessary for the combustion. By using steam for spraying, no oil accumulates in the flue when the flow is regulated, consequently a complete combustion of the oil takes place. Looking at the question from the point of cost, it is not probable that the compressed air can be produced cheaper than the necessary quantity of steam taken direct from the boiler. It is, in fact, but a very small quantity which is necessary for doing this work, when the pulverizator is properly constructed. The chief point in the construction of the pulverizator is to avoid waste of steam—that is to say, to construct the nozzle in such manner that every particle of steam takes care of a corresponding particle of oil. This object will best be secured when the openings for the steam, as well as for the oil, are made long and narrow, and are placed as close to one another as possible. All the different Russian constructions are made in this way. The openings are about 1¼ in. long, and ⅛ in. to ⅙ in. wide. As the oil sometimes contains paraffine, which is likely to choke this narrow opening, it is essential to have an arrangement by which steam can be led through the oil-passage to clean it out. The rest of the construction may be varied to suit particular cases, and with a view to facilitate and cheapen the manufacture." After mentioning the general advantages, the author spoke upon the special advantages accruing to railways and steamships. "The valuable spaces at railway stations, which have now to be sacrificed for accommodating coal supply, could be reduced by about two-thirds, as only half the tonnage would have to be kept in stock, and this quantity can be stored more economically in point of space than the same quantity of coal. A considerable amount of labor employed in storing coal and loading tenders can be saved, and the oil can be taken in simultaneously with the water supply, as quickly and in a like manner. The avoidance of smoke and blowing safety-valves will greatly add to the comfort of the passengers, a point for which the railway companies are usually prepared to make considerable sacrifices.

"For steamships the advantages of using liquid fuel are of still greater importance. The oil can be kept in ballast tanks at the bottom of the ship, an arrangement which greatly augments the stability of the vessel, and can, as it is consumed, be replaced by water. The size of the stokehold can be reduced considerably, and the number of stokers diminished in the proportion of one to four. In stormy weather it is of great advantage. The danger of fire in the coal-bunkers will not be replaced by any similar risk connected with the use of oil. Lastly, it may be mentioned that a ship having oil at its disposal may, by pouring a certain quantity overboard in rough weather, avoid much trouble. For torpedo-boats the use of liquid fuel is possibly of still greater importance than for any other vessels; the entire absence of smoke will help to avoid detection and possibly destruction, and the saving in space is of the utmost importance as well as the possibility of raising steam quickly. Oil-firing greatly increases the rapidity of raising steam of high pressure; fire-grate and ashpit can be done away with altogether, the length of the funnel can be reduced, and a system of water tubes is better suited to the fierce fire of liquid fuel than the straight or curved surface of an ordinary thick boiler plate. No boiler specially designed for liquid fuel is yet in the market, but the subject leaves certainly a wide field for the boiler designer who, with liquid fuel, can obtain a flame which can be controlled, directed, and given uniformity much better than a coal fire, and which is less dependent upon air-currents.

"A disposition to use liquid fuel has already been shown in this country, both for locomotives and steamships. A certain number of locomotives, and even stationary boilers, have been fitted to use oil, and have burned the tar oil which was ob-



SECTIONAL CAST-STEEL SCREW, BUILT BY THE DRY DOCK IRON COMPANY, BAY CITY, MICH.

tainable. A small quantity also of astatki, which had been shipped to this country, has been employed for steamship use.

"As regards the supply, America and Russia produce very different classes of crude oil. The American oil gives about 80 per cent. of kerosene, and the remainder is partly utilized for making other petroleum products. There is, therefore, no likelihood of getting any great supply from these fields. The Russian crude oil, on the other hand, only gives about 35 per cent. of kerosene and other products, leaving 65 per cent. of astatki for fuel; there are, therefore, if not unlimited, at least very considerable quantities at hand from these fields.

"At present no oil territories which approach the American or Russian in magnitude are worked."

The author mentioned various localities of an oil-bearing character, among others, Burmah, the West Indies, Canada, Mexico, etc.

"In Russia, boring operations commenced 20 years later (1879), and the number of wells drilled is considerably less, but they have been more productive than the American. On account of the different geological formations of these two countries, the modes of boring are different, as well as the form of the wells. In America a well is often drilled through rock from top to bottom; the average diameter is 8 in. at the top, and the depth is about 2,500 ft. A complete outfit for drilling such a well costs $10,000, and the wages of the drillers is $3 to $4 a day. If drillers are secured for work outside the United States, they receive $125 a month and traveling expenses.

"The safest and most practical way to proceed will, in most cases, prove to be the following: After thorough surveying of the particular field by competent experts and geologists, and after having located a number of places suitable for trial borings, the necessary plant has to be brought into operation, not so much with a view of getting hold of the largest quantity of oil, for the storage of which no provision has usually been made, but for ascertaining the depth at which the oil will be struck, and as a guide in defining the extent of the oil-bearing strata. For this purpose it is not necessary to go beyond the depth of, say, 1,000 ft. If the strata met with, which has to be carefully recorded, do not give satisfactory results, another place has to be tried, and so on, until the operators have thoroughly sounded the ground, and are perfectly convinced that plant for larger and deeper wells is justified. The cost of plant, the amount of skill required in the operations, and the time employed progress at a much quicker ratio than the depth; in other words, a 3,000 ft. boring costs more in money and skill than, say, five borings 1,000 ft. each; and a territory is much better tested by 20 borings of 500 ft. than by five borings of 2,000 ft. If oil is found only at 3,000 ft. in a new territory, it does not, in fact, present very encouraging prospects, unless, of course, the quantities found should be very considerable.

"The system to be recommended for such borings are the ordinary artesian well boring, with rods and ropes and portable derrick; for later borings a fixed rig iron and wood for use of the American and Canadian boring system, and heavier tools may be adopted. One outfit for every two, three, or even four test holes may be sufficient, and requires but one experienced man with two unskilled helpers for its manipulation. If steam power is used, an additional man will be required. Responsible technical supervision of the operations is, of course, indispensable in any case."

The discussion was opened by the Chairman, who said he could confirm what had been said as to the advantages of liquid fuel used on railway trains. Liquid fuel was adopted on one of the railways of Argentina in 1890, and there were 12 locomotives burning it. Within the last few months a petroleum-tank steamship had been driven across the Atlantic by liquid fuel. He also spoke upon the question of burners.

Mr. Nelson Boyd stated that the combustion of a hydrocarbon was much more perfect than that of coal, there was not the loss in smoke and clinker, and, in locomotives, there was none of that coating of the tubes with carbon. The great difficulty in England was the price, which was equal, at present, to coal at 23s. per ton. Another important point was the quantity of steam required for the pulverizators.

Mr. Edwin Harwood stated his experience in his yacht, the *Ruby*, remarking that his difficulty had been in the adjustment for the small amount of oil utilized.

Mr. W. Warren, Sir W. Percival, and others contributed to the discussion, giving their experience in regard to the use of liquid fuel.

The voyage across the Atlantic of the steamship *Baku Standard*, a short time ago, revived the question of the use of oil as a motive power for steamers and locomotives. About 10 years since the question was somewhat acute, but now we are enabled to take a more enlightened view of the subject. The question is of some importance to coal-raising districts like that of South Wales, hence a short summary of the position created may be of use and interest at the present time. The question revolves itself into two main considerations—is it possible to use petroleum or other mineral oils to such an extent as to curtail seriously the production of coal; and in so doing affect to a large extent the labor market of miners, sea-going firemen, and railway stokers? The latter part of the query, of course, depends entirely on the answer given to the former. Well, the facts may be briefly stated thus: There are a great number of steamers and locomotives (which are now driven by steam raised from petroleum) in the Caspian and the Euxine oceanic districts. A few steamers similarly ply on the river Plate, and a few are now making inter ocean voyages to America and the Black Sea; and the Great Eastern Railway, in our own country, has adopted the use of shale oil for the locomotives. So that there is no doubt of the practicability of the experiments. In 1885 the screw steamer *Himalaya* (afterward called the *Marahu* when taken to Brazil) made a trial trip from London to Granton. The result was a passage of 54 hours at a consumption of 8 galls. of oil per hour. The cost was estimated at £4 against a possible expenditure of coal of £7 per day. Only two firemen were required, in place of five if coal had been used. In the same year the Central Pacific Railway Company tried the oil plan on their steamers, oil having been found on the Pacific Coast. The cost of oil for their steamer *Thoroughfare* for five months was ascertained to be 56 per cent. of that of coal. Put in another way, it was found that 80 imperial gallons was equal to 1 ton of coal for steam purposes. The cost being as $4 to $7. In the recent case of the *Baku Standard*, the owners report that the mere weight of the fuel was at the same ratio—namely, 4 to 7. There was also a large saving of labor in engine-room department. If this be so, in the intense competition of trade, there must be a strong temptation to increase the number of tank steamers, and to use oil as a motive power. But as cost must be the governing factor, if the price of oil should rise, in consequence of an increased demand, reversion to coal would be very quick Now, to test this point, let us consider the amount of oil production in the world. In 1889 a statistician computed the world's production of petroleum and its congeners at 10,500,000 tons made up thus:

	Tons.
United States of America	6,000,000
Russia	3,000,000
Galicia	1,000,000
Burmah, Canada, Peru, Germany, Roumania, Transcaspia, Australia, Japan, etc.	500,000
Total	10,500,000

Since then America has not increased much, if at all. Russia has about doubled her output. The probability is that, in this present year, the total output is about 14,000,000 to 15,000,000 tons. Taking the *Baku Standard* experiment, confirmed by that of the *Thoroughfare*, at 7 to 4 against coal, it would appear that, say, 15,000,000 tons of petroleum is equal, as a steam raiser, to about 26,000,000 tons of coal for the same purpose. The production of coal is over 500,000,000 tons per annum in the known world. How, therefore, can 15,000,000 tons of oil compete with such an enormous quantity of coal? It is alleged that the production of oil is unlimited; that it can be made from coal itself and other products; that the cost (or saving) in using it is as 4 to 7; and therefore it must seriously affect the production of coal in a very short time.

On the other hand, the arguments against the position are: That the more it is used the higher the price will rise, and thus level the cost of its use to that of coal; that in America many wells have run dry, and Russian and other sources of supply may also experience the same fate; and that the demand for oil at the present time (unlike coal) is mainly for domestic use, and for other purposes than steam-raising.

Altogether, at the present time, it would appear that coal-owners and their workmen may rest contented that petroleum cannot yet enter into the race of competition with them. It is true, however, that the Russian supply is increasing enormously, and that tank steamers are being built to a limited extent. As an index of what Russia is doing in the way of supply to other countries, it may be stated that in 1888 she exported 545,855 tons of petroleum, which in 1892 (only four years) rose to nearly double the quantity, or 900,887 tons.—*South Wales Investment Circular.*

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.

SECOND SERIES.—CHEMICAL METHODS.

VIII.—METHOD OF DETERMINING SILICON IN STEEL.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

OPERATION.

Put 2 grams of fine borings in a 12-oz. royal Berlin porcelain casserole, and add 80 c.c. of a mixture of nitric acid, sulphuric acid, and water. Cover with a watch glass and allow action to cease. Then evaporate, if desired, over a lamp direct, until sulphate of iron begins to separate, then transfer the dish to an air-bath, heated to about 300° F., and continue the evaporation until fumes of SO_3 are given off. Allow to cool, add 250 c.c. of distilled water, and heat carefully until the sulphate of iron has all dissolved, then filter at once. Wash with water until most of the iron salts are removed, and then with dilute hydrochloric acid, as long as the washings are colored with iron salts; finally wash with water again, until the washings no longer react for chlorine, then ignite and weigh. Treat the contents of the crucible with a little dilute sulphuric acid and a few drops of hydrofluoric acid, evaporate to dryness, ignite and weigh again. The difference between the two weights is silica.

APPARATUS AND REAGENTS.

It will be observed that a porcelain casserole is designated as the characteristic piece of apparatus for this method. Of course platinum dishes and good quality porcelain evaporating dishes may be used, but, all things considered, a casserole seems best. Glass should not be used, as some of the separated silica apparently adheres to the glass, and cannot be removed by the feather or rubber tube on the end of a glass rod. Direct experiments on the same steel, everything being exactly alike, except one determination was in a porcelain casserole and the other in a beaker, show lower results in the beaker, amounting to one or two-hundredths of a per cent. The results in the porcelain were confirmed by repeated tests in platinum on the same steel. For a single determination, the air-bath recommended in "The Chemical Analysis of Iron," by A. A. Blair, 2d edition, p. 20, is very satisfactory. For a number of determinations at once, an oven gives excellent results.

The mixed acids for solution are made by adding 20 c.c. of concentrated C. P. nitric acid to 40 c.c. of distilled water, and then adding to this 20 c.c. of concentrated C. P. sulphuric acid. Where a number of determinations are to be started at the same time, it is more convenient to mix the quantity of acids required all at once.

The dilute hydrochloric acid for washing is made by adding one part concentrated C. P. acid to four parts of distilled water.

Hydrofluoric acid of good quality, practically free from residue, can now be obtained in the market, in ceresine bottles.

CALCULATIONS.

Atomic weights used, oxygen, 16; silicon, 28; molecular formula, SiO_2. Since 46.67 per cent. of the SiO_2 is silicon, if the weight found is multipled by this figure, the result will be the silicon in 2 grams of steel, and this figure multiplied by 100 and divided by two obviously gives the perceutage. This may be simply stated in the following rule: Express the weight of SiO_2 found, in grams, remove the decimal point two places to the right, and multiply by 0.2333. The product will be the percentage of silicon in the steel. Thus if the silicic acid found is 0.0027 gram, the silicon is (0.27×0.2333) 0.063 per cent.

NOTES AND PRECAUTIONS.

It will be observed that this method oxidizes the silicon in the steel by means of nitric acid, and then dehydrates the silicic acid formed by means of concentrated sulphuric acid, so that it can be caught in a filter, finishes the dehydration by ignition and weighs up as SiO_2. Any residue of iron or other material not washed out is left behind after the treatment with hydrofluoric acid. There is considerable evidence that the SiO_2 is not completely dehydrated in the sulphuric acid by this method. After the water is added and the iron salts are in solution, the appearance of the silica in the liquid is more or less gelatinous, also, as is mentioned below, the SiO_2 goes into solution again under certain conditions. It is believed that if the directions are carefully followed, the results will be accurate to within perhaps half a hundredth of a per cent.

The reason for the use of a porcelain casserole has already been given.

The mixed acid gives exactly the same results as though the steel is dissolved in dilute nitric acid, and then dilute sulphuric acid added. It simplifies the manipulation a little to add the acids all at once.

A careful manipulator may succeed in evaporating over the lamp direct until the sulphuric acid fumes strongly, especially if the material is stirred continuously, but after the sulphate of iron begins to separate there is much danger of loss by spirting. The air-bath is much more sure. When a number of determinations are carried on at the same time and there is no great hurry, excellent results may be obtained by adding the mixed acids to the borings, putting the casseroles at once on a steam plate whose temperature is about 275° F., and allowing them to stand without further manipulation over night. Where the air-bath and shorter time are employed, the casserole should be set down into the air-bath, below the line of the liquid inside. With the air-bath or on the steam plate, stirring is not essential.

It has been proposed to add Nordhausen sulphuric acid to the dish after the principal part of the nitric acid has been driven off, to get the strong sulphuric acid necessary to dehydrate the SiO_2 and thus to save the time required to concentrate the sulphuric acid to the proper point. Our experience with this modification is that the Nordhausen of the market is rarely pure enough to be trusted, while if Nordhausen is made by adding SO_3 to concentrated C. P. acid, there is considerable difficulty in the manipulation of the SO_3. That which comes in tin cans is very difficult to open and put into the strong sulphuric, without at the same time being contaminated, while if that in glass bulbs is used there is much danger that some of the glass of the bulb will get into the determination. The time and labor saved by this modification is not great.

It will be observed that directions are given to filter at once, after the iron salts are dissolved. Direct experiments following the manipulation given above show that after the water is added and the iron salts are in solution, if the material is allowed to stand before filtration 24, 36, or 48 hours, quite large amounts of the silica are redissolved and lost. This statement has been disputed, but our own experiments have been confirmed by other workers. It seems probable that a few hours' standing would make very little difference, but as there seems to be no good reason for dilution until one is ready to filter, we have not thought it worth while to study the cause of the discrepancy in the statements. The manipulation which we recommend is certainly the safer.

The use of half strength hydrochloric acid has been recommended to wash out iron salts. The experiments of some chemists seem to indicate that the silica obtained as above is perceptibly soluble in hydrochloric acid of this strength. As the iron salts seem to be completely removed by the more dilute acid, we prefer to use it as a precautionary measure.

If the dilution and washing have been managed with care, the silica obtained is generally perfectly white, and the residue after the treatment of hydrofluoric acid is very small. If there is a tint of iron oxide the residue will be larger. In no case should the hydrofluoric acid treatment be omitted when determining silicon in steel.

MASTER CAR BUILDERS' CONVENTION.

The twenty-eighth annual convention of the Master Car-Builders' Association was opened on the morning of June 12, at Saratoga, N. Y., with President Grieves, of the Baltimore & Ohio Railroad, in the chair. The preliminary business, including the President's address, Secretary's and Treasurer's reports, was transacted in the new convention hall. A *résumé* of the Secretary's report shows that there are now 326 members of the Association, including active, representative and associate members. The Treasurer's report showed that the expenditures made during the past year were $8,018.84, leaving a treasury deficit of $21.30. In the report of the Executive Committee a suggestion was made that the committee be empowered to bring the subject of the Master Car-Builders'

standards to the attention of the American Railway Association, and especially that of the rules of interchange, inasmuch as if these rules were sanctioned by the latter association they will probably be greatly strengthened.

After this brief introductory business the regular reports of the committees were taken up for consideration. The first offered was that on indelible pencils, the committee on which communicated with a number of manufacturers during July and August of last year, laying down the following requirements of the properties which a suitable indelible pencil should possess. They were these:

1. A clear black pencil, the writing of which cannot be erased by india-rubber or by other means without considerable trouble.
2. The material from which these pencils are made must retain its original conditions and must not become hardened or spoiled with age.
3. The pencils must be so that they can be readily sharpened and the leads not easily broken by clumsy-handed men.
4. The writing must not smudge or run if wet.
5. The writing must not fade by exposure to light.

After subjecting the pencils submitted to various tests similar to that of the regular use on interchange cards, and taking up in details the qualities of the various samples, the committee stated that they felt it possible for them to specially recommend pencils Nos. 13 and 14, American carbon pencil No. 113, American editor pencil No. 185; while pencil No. 12, Eagle No. 482, pencil No. 15, Dixon's leather and cloth marker No. 789, pencil No. 18, Dixon's marking pencil No. 784, pencil No. 19 and Faber's No. I, Unverwischlich, can all be considered as good pencils, filling the requirements fairly well.

The next paper offered was that on the standard sizes for catalogues, specifications, etc., of which Mr. Godfrey W. Rhodes was Chairman. It is unnecessary to reprint the whole of this report, but we give the sizes which were recommended for the Association's standard.

POSTAL CARD CIRCULARS.

1. 3½ in. × 6¼ in.

PAMPHLETS AND TRADE CATALOGUES.

2. 3½ in. × 6 in.
3. 6 in. × 9 in.
4. 9 in. × 12 in.

SPECIFICATIONS AND LETTER PAPER.

5. 8½ in. × 10¾ in.

The reason for these recommendations is that the postal card circulars is that of the size ordinarily used; that for pamphlets and trade catalogues allows the paper to be folded and cut economically without much waste from stock paper 35 in. × 37 in. The recommendations for specifications and letter paper was chosen, as it can be cut from folio sizes 17 in. × 22 in. The report then made recommendations in regard to a cheap file case for filing the papers of the above dimensions.

This report was followed by a report on steel-tired wheels, of which Mr. R. E. Marshall was the Chairman. From the replies received to its circulars from the members of the Association the following information was tabulated by the committee:

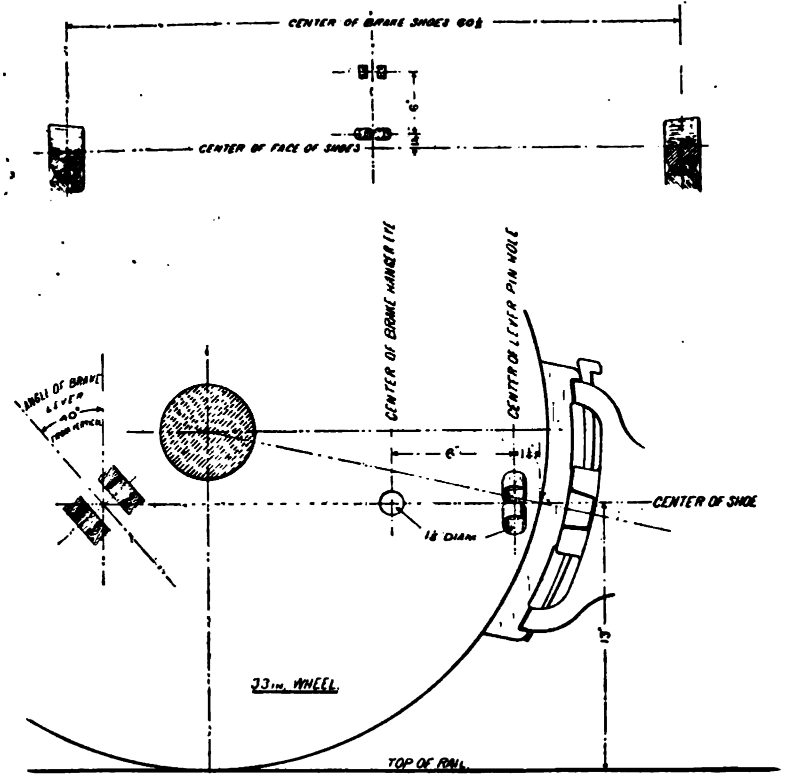
It seems to be the consensus of opinion that 1 in. is the proper limit of thickness for tires. On account, however, of the variety of sections of tires used, it is important that this limit be clearly defined; and your committee, therefore, offers the following recommendations:

1. That the limit for thickness of tires of all steel-tired wheels shall be 1 in., measured normally to the tread and radially to the curved portions of the flange through the thinnest part within 4¼ in. from the back of the flange—the thickness from the latter point to outer edge of tread to be not less than ½ in. at thinnest part. (See fig. 1.)

2. That, in order to facilitate inspection, a small groove shall be cut on outer edge of all tires at a radius ¼ in. less than that of the tread of tire when worn to the prescribed limit.

3. That the above recommendations shall be submitted to letter ballot for adoption as "recommended practice" of the Association.

The report was also accompanied by numerous engravings showing the methods of tire fastening adopted by all of the prominent wheel manufacturers in this country, as well as those of the Krupp and Arbel wheels, manufactured in Germany and France. These methods of fastening have been so repeatedly published that it is unnecessary for us to reprint them here. The report also includes tables giving the numbers of different makes of steel-tired wheels in use, with certain schedules of defects which have developed in the running of each wheel.



PROPOSED DETAIL FOR BRAKE BEAM LOCATION.

The committee having charge of the consideration of brake beams report that they found it impossible to give the dimensions for the location of the beam and brake relatively to the center line of the metal beam, and they therefore take as a starting point one which was absolutely fixed and had no reference whatever to a particular construction of beam. The line drawn horizontally and parallel to the truck and passing through the point of contact of the center of the standard Christie brake shoe with the tread of the wheel was found to fulfill these requirements. Inquiry showed that a standard distance of 60¼ in. between the centers of brake shoes has been adopted by a very large proportion of the roads using a metal beam. This is also true of the adoption of the Master Car-Builders' standard lateral inclination of 40° for the brake lever. The committee therefore recommended that one standard height for both inside and outside beams should be adopted, and this is 13 in., measured from the top of the rail to the center of the brake shoe, as shown in the figure. The construction of trucks naturally renders it more difficult to get a standard height for inside-hung beams than it is for those hung upon the outside. If, however, the Association should consider that there should be one height for inside and another for outside beams, a recommendation of 14½ in. for the outside and 13 in. for the inside was made.

In the discussion which followed, Mr. West called attention to the advantage of the outside hung beam, in that when an automatic coupler falls down it will strike inside brakes hung at a height of 13 in., whereas it would be cleared by the higher outside beams.

The report on safety chains for freight cars may be reduced to a recommendation on the part of the committee that they are necessary only on flat and low side gondola cars, which are frequently used as twins and triplets to carry lading, extending over two or three cars, and the committee did not recommend the general use of safety chains on any classes of cars but with a view of securing interchangeability with any that might be applied, recommended a chain located 27 in. from the center of the car on either side, made of 1¼-in. iron, secured by eye-bolts 1⅜ in. in diameter passing through the end sills, with a 4-in. hook on the left-hand side as you face the car, and the

end link of the other being of 1¼-in. iron; the inside hook to extend 6½ in. beyond the inside face of the knuckle and the link of the corresponding chain to extend 5½ in. outside this same point, leaving a slack of 11¾ in to compensate for curvatures. The general impression conveyed by the discussion was that safety chains were not only unnecessary, but it would be rendered useless by the neglect of trainmen to hook them.

Mr. Waite, of the Lake Shore Road, called attention to the general practice of his road of chaining cars together where long structural iron or telegraph poles were being transported on two or more cars. On their passenger equipment the safety chains are placed 14½ in. from the center. This report was the last one read on the session of the first day, and the next one opened on the morning of the 13th with the reading of the report of wheel and flange gauges, which will be dealt with fully in a future issue of this paper.

After this discussion, the time of the convention was occupied by the report of the Arbitration Committee on the proposed amendments to the Rules of Interchange.

Thursday morning's session was opened by a continuation of the discussion of the Rules of Interchange, and before the session closed the reports on road tests of brake shoes was submitted, which is merely a report of progress and quite in line with the editorial paragraph commenting on the probable work of this committee in our issue for June. It is expected, however, that the tests will be completed within three months and that the report will be made out as soon thereafter as possible.

The report of laboratory tests of brake shoes gave a *résumé* of the work which has been done by Morin and Poiree, in France, and by Captain Douglass Galton, in 1878, in England The report also included tests of the Pennsylvania Road, made in 1891 and 1892, and had an appendix in the shape of a description of the brake-shoe testing appliance that has already been published.

On Friday morning the first report read was that on the lubrication of cars, from which we make the following abstract:

LUBRICATION OF CARS.

The committee opened their report by a discussion of the relative care which is given to locomotives and cars, and reported that there was quite a general lack of information as to the best means of securing proper car lubrication. The grades of oil in use on American cars vary from a very cheap crude oil at 5 cents to the best refined Galena oil at 35 cents per gall. Twenty-one of the roads replying are using Galena oil, while 17 roads use common West Virginia or black oil, and eight roads use either special oils or else part Galena and part common black oil.

From the replies received we find that the cost of oiling cars per 1,000 miles varies from 6 cents to 41$\frac{6}{10}$ cents on passenger equipment, and from 6 cents to 26$\frac{3}{10}$ on freight cars.

We find that 21 out of 45 roads use special cooling compounds to prevent or reduce hot boxes, in addition to the regular oil lubricant. A singular but significant fact is noticed, that with but four exceptions the use of special cooling compounds is confined to the roads using the cheap grade of oils, such as common black or West Virginia. It seems that of the 25 roads who find no need for a special cooling mixture, that 21 of them are those who use only the high grade Galena oil. This would seem to indicate clearly that the high grade of oils are better lubricators and need no expensive assistants in the shape of cooling mixtures. This suggests to your committee that in figuring on the comparative economy of different grades of oils, the feature of there being no necessity for a special cooler for use of trainmen and inspectors should be fully recognized.

From the 21 roads using special cooling mixtures, 2 roads report poor results, 7 fair results, 11 good, and 1 very good. It can safely be said in this connection that there are undoubtedly many cases of hot boxes occurring to-day that can be partially or wholly remedied by these special coolers judiciously used, but your committee firmly believe that many, if not most of these cars could be equally well cared for by the use of trainmen or inspectors of a proper quantity of freshly soaked waste and oil, carefully applied, the poor and dirty waste in the box being first removed. We further believe that by proper care being taken, in connection with various important points, which will be referred to later, that few if any hot boxes need occur.

The record of hot boxes per 1,000 miles on passenger equipment, as reported, shows quite a variation, running from .001 to .19, the average being .0516; or, in other words, the best record was one hot box in 1,000,000 miles run, while the poorest had one in about every 5,360 miles run, the average being one in about every 20,000 miles. A curious fact is shown by the reports—namely, that the three roads showing the best records and the three showing the poorest, all are using the highest grades, and consequently the highest-priced oils. This fact shows quite clearly that, though the best results can only be obtained by the use of the best grades of oil, poor results may be had with the same oil where insufficient attention is paid to other important features; or, in other words, the quality of lubricant is only one of the many details that must be looked after in the successful lubrication and cool running of car journals.

Another very curious development is the large variation in the number of gallons of oil used to the thousand miles run. This runs, on passenger equipment, as high as 4⅛ galls. and as low as $\frac{3}{10}$ of a gallon, the latter figure being on a short road with but few trains, which runs through a territory free from sand. Most roads in oiling passenger equipment use from 1 to 2 galls. per car per 1,000 miles run. The great variation will account readily for the well-oiled ties on some lines, and the wheels so often found thickly coated with grease and dirt. There is undoubtedly room for greater economy and much improvement by more careful supervision of car oiling.

In the oiling of freight equipment a similarly large variation in practice is noticed from the replies received. The minimum amount of oil used is slightly less than ¼ of a gallon per 1,000 miles, while the maximum is 2¼ gallons.

Your committee feel warranted in recommending a good grade of all-wool waste, which is free from dirt, and is composed of good long fiber, as the best material for packing that can be obtained. The data at hand does not warrant giving any reliable conclusions as to the comparative efficiency and economy of cotton waste and elastic wool.

The opinions of roads with regard to the comparative freedom from heating of iron and steel axles seem to be about equally divided, and about all that can be said is that probably steel axles are freer from flaws and seams in journals than iron, and for that reason heat less from those causes. But, on the other hand, the grain of steel axles being much closer than in iron, there is less opportunity for the oil to be held in the minute spaces between the molecules of metal, and, as a consequence, is somewhat more difficult to lubricate steel journals, if they are loaded to anywhere near their full capacity.

The subject of proper mixtures and metals for journal bearings, and the kind and quality of metal for linings, is one which the replies to inquiries show to be in a very undecided state. There seems to be no uniformity of opinion on any kind of metal or any proportions of mixtures. On a few points as to journal bearings there is almost entire unanimity. All but two out of 46 roads favor a solid lead-lined journal bearing. Some of those so deciding are to a slight extent using filled shell bearings. All roads agree that the journal bearings should be ground or bored, and lined, on a radius larger at least by $\frac{1}{32}$ in. than the journal they are to run on. Some roads wish this to be as much as $\frac{3}{16}$ in larger. It is astonishing to find a few roads who neither bore nor grind their journal bearings, but simply clean the surface of the bearing and coat them with $\frac{1}{16}$ to $\frac{3}{16}$ in. of lead or babbit, and then are surprised when the lining is worn through that the hard, sand-lined surface of the bearing should begin to cause heating and cutting of the journal. No worse or more dangerous practice has come to the notice of your committee than allowing practically a rough unfinished casting to be used on a nicely polished journal to carry the weight of a heavy passenger coach, or sleeper, moving at from 40 to 60 miles an hour, with its freight of human lives who might be instantly killed or maimed by the excessive heating and consequent breaking off of a journal. Your committee hope that every member of this Association will discountenance such a dangerous and expensive practice, as trying to avoid the slight cost of properly boring new journal bearings at the possible and probable risk and cost of hot boxes, cut and broken journals, and possible wrecks with their attendant losses.

The information received by the committee indicates the almost universal use of lead, or lead with a very small percentage of antimony, as the best metal for lining bearings.

Wool has greater elasticity and retains it much longer, although it does not absorb and feed the oil quite so quickly as cotton. Oftentimes some of your committee have seen car-oilers or trainmen, and repairers, repacking or partially repacking boxes with dry waste, over which an excessive amount of oil has to be poured to give it the appearance of being properly packed. Such practice has done incalculable injury, and cannot be too strongly discountenanced. It should be a universal rule, which ought to stand in writing in every railroad shop, that all waste must be soaked in oil, being well covered, for at least 24 hours before being used; if possible it

should have 48 hours for the oil to act on it. In order that waste so saturated may not be used with more oil than it will properly hold, before using it should be drained from any surplus by being placed on a screen placed so the drainings will drip on to the still soaking waste beneath.

Experience has shown to us the fact that some of the most serious difficulties due to journal bearings have not been due to varying proportions of the different constituent metals, but rather to mechanical defects. It is an open question if it is not better to hold to the curved top bearing, with its few cases of hollow journals, than to make the bearing straight, thereby changing the standard and having more or less hot boxes in consequence. The committee deem it wise to recommend to the consideration of the Association the changing of the present standard $3\frac{3}{4} \times 7$ journal bearing and key to the form given to the $4\frac{1}{4} \times 8$ bearing and key—namely, make the top of the bearing straight and curve the top of key instead of the opposite, as it now is. This change could be made without interfering with interchangeability of parts, and in a few years all cars would be changed, with the benefits accruing yearly to each car changed. We would also recommend that all Master Car-Builders' journal bearings and keys made or purchased be required to pass the inspection and test of the gauges shown in fig. 2.

The committee also recommended certain gauges to be used in connection with the sizes of brasses and wedges, so that the fitting would be properly done.

Before concluding this report, your committee have one rather radical recommendation to make—namely, that for the best results to be obtained in line of good lubrication of cars and freedom from hot boxes, oil cans and clear oil should be once and for all removed from and forbidden to be used in shops, shop yards, and by train crews. Clear oil to be used only to a limited extent in interchange inspection yards. The reason for our recommendation is that most cases of heating of journals come from the waste sagging away from the journal, and therefore no oil is fed to it. If oil is poured on in such a case it only lubricates for a few minutes, for the oil still cannot feed on to the journal; but if instead of oil the dope bucket is used a small quantity of freshly soaked waste will furnish the necessary oil and will at the same time fill the box with waste up close around the journal, allowing the remaining oil in the balance of the waste to feed to the journal. If at shops all cars are freshly packed with saturated waste, or the box is properly filled with such, there is surely no necessity for the oil then. The use of waste in this matter will save much in the needless waste of oil, as well as put the oil boxes in the best condition for good service.

This was followed by the report on freight car brakes, in which the committee gave a detailed statement of the replies which were given to the nineteen questions sent out in their circular of inquiry. From these replies it is seen that a large majority of car-builders were in favor of a 5 ft. wheel base, and in accordance therewith that base was the subject of a recommendation on the part of the committee. The committee also recommended that the size of arch bars be made 4 in. $\times 1\frac{1}{4}$ in. at top, 4 in. $\times$ 1 in. at the bottom, with a tie bar of 4 in. $\times \frac{3}{4}$ in. No recommendation was made of special designs for arch bars, as there was no uniformity in this particular.

In the report of steam heating, the same methods were followed as in the preceding report. There were, however, twenty-nine questions instead of nineteen. From these it is seen that there are at present 5,869 passenger cars equipped with steam-heating apparatus or other improved methods and 6,432 cars not equipped. This represents a mileage of 30,011 miles.

The committee also received answers from 13 roads representing 16,947 miles and 2,414 cars which have not adopted steam heat, making a grand total of 5,869 cars equipped and 8,846 not equipped.

The report on air-brake and hand-brake apparatus on cars resulted in the showing on the part of the committee that the hand-brake apparatus as usually applied to the passenger coaches was inadequate to give a full brake pressure on the wheels on account of the lack of leverage obtained with the small hand wheels in use. These latter were frequently placed so close to the center of the car that when coupled with the vestibule they were inoperative. The greater portion of the report, however, was taken up with a discussion of air-brake apparatus and its proper maintenance, the committee urging that greater care should be taken in the inspection and better arrangements be made in order that this inspection might be thoroughly done. It showed that very few roads were equipped with adequate facilities for doing this, and then gave a detailed description of a large plant wherein the yards and shops were so piped that inspection and adjustment of the air-brake apparatus was possible at all points. In some cases repairs had better be made by supplying new parts, such as defective triple, which could be removed and replaced in fifteen minutes and had been done in seven. In regard to the defects noticed at interchange points, there is one which has attracted considerable attention, namely, that of the cutting of coupling gaskets. In an effort to keep the apparatus clean many companies are endeavoring to enforce the hanging up of the hose. When this is improperly done the bent hose becomes a receiving basin for flying dust and cinders, in which case it would be preferable to let it hang down. The hook on the dummy coupling is also very frequently inserted inside the gasket, with the result that the usefulness of the latter is destroyed in a short time. The remedy suggested by the Central Railway Club was endorsed by the committee. It consisted of the enlargement of the point of the hook on the present dummy coupler, which will prevent its improper use, thus ensuring freedom from damaging contact with the gasket and exclusion of dirt whenever the coupling is hung up.

The Committee on Car Ventilation summarizes the ideal conditions of the same in ten paragraphs which would be very difficult to realize. These were:

1. The admission of 30 cub. ft. per minute per passenger of fresh air and the carrying off of an equal amount of foul air summer and winter.

2. The fresh air so admitted must not be moving at a speed of more than three or four miles per hour in winter time.

3. Fresh air admitted must be at a temperature in winter time of about 70° F.

4. Fresh air so admitted in winter time must have added to it a proper degree of moisture for the temperature at which it is admitted, according to the average humidity of the atmosphere when at 70° in the climate in which the cars are running.

5. No system of winter ventilation can be successful unless means for the fresh-air supply are provided independently of and separately from the windows and doors as well as the ventilators for carrying off the foul air.

6. The fresh warm air should be distributed through as many openings and as low down as it can be conveniently arranged for, and the foul air should be carried off through as many small openings in the roof of the car as can conveniently be arranged for in winter.

7. The ventilation should be entirely independent of the speed of the train and act equally as well whether the car is standing or running.

8. The ventilation should be so arranged that there will be a plenum or slight excess of pressure inside the car, so that all drafts will be outward instead of inward, and smoke and dust thus excluded.

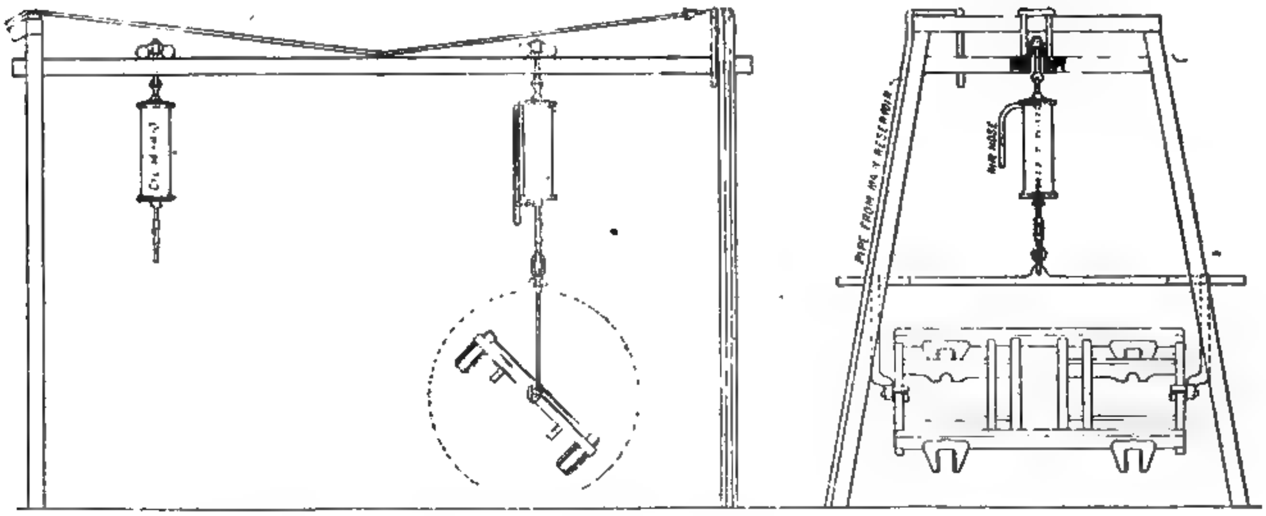
9. It is most desirable that double windows should be used, and so arranged that they can be locked fast in winter time, but readily opened in summer time.

10. It is most desirable that an inside swinging door be used, so as to form an air lock or inside vestibule, to prevent the admission of cold air and dust every time the doors to the platform are opened.

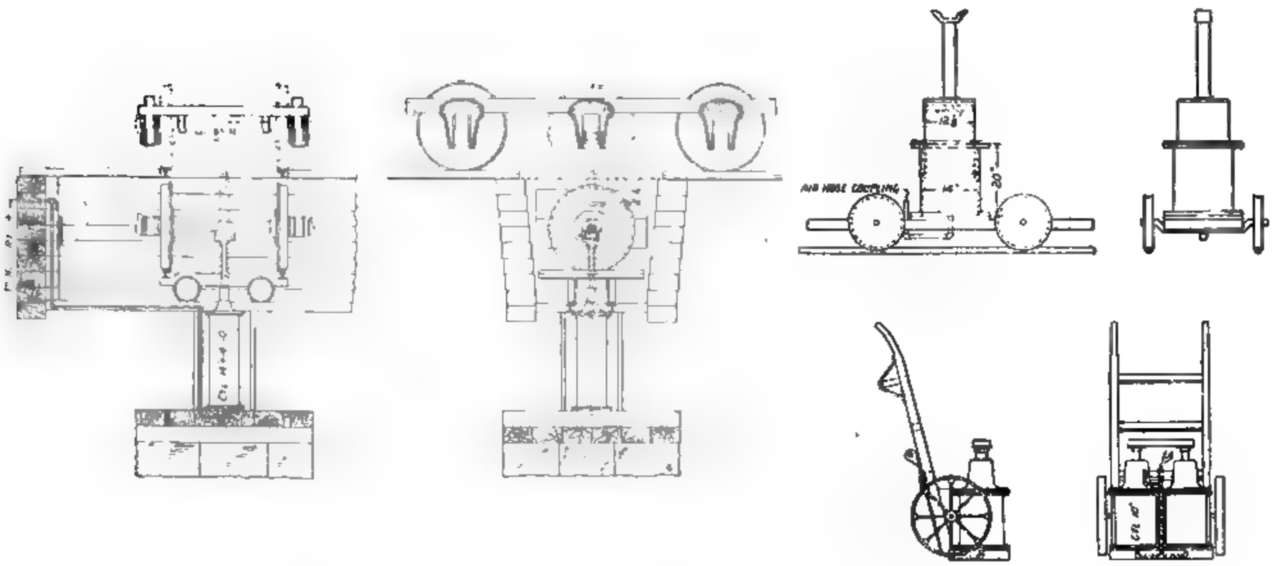
These conditions were followed by a discussion of the unhealthfulness of apartments containing more than four parts in 10,000 of carbonic acid gas, and also by tables showing the conditions of air in sleeping cars, the shop yard at Aurora, Ill., chair cars, suburban coaches, and a few miscellaneous tests. These average as follows: Sleeping cars, .18; shop yard, .04975; chair cars, .10725; suburban coaches, .1375. The miscellaneous tests were: For an office occupied by six persons, with a door to the hall on a cold day, .085; the opera house in rear of floor seats, house full, .143; chemical laboratory, two persons and two lamps burning, .040.

This shows that the air of sleeping cars is the most impure that was encountered by the committee making the investigation, and that the purest air was in the laboratory occupied by two persons with two lamps burning, even more so than that of the shop yard, which was probably contaminated to a greater or less extent by the gases from furnaces and locomotives; but when we take into consideration the fact that there was more than four times as much carbonic acid in the air of the sleeping car as there was in the laboratory, it is readily understood why there is so much complaint of sleeping car ventilation and why there are so many headaches in the morning after a night's travel.

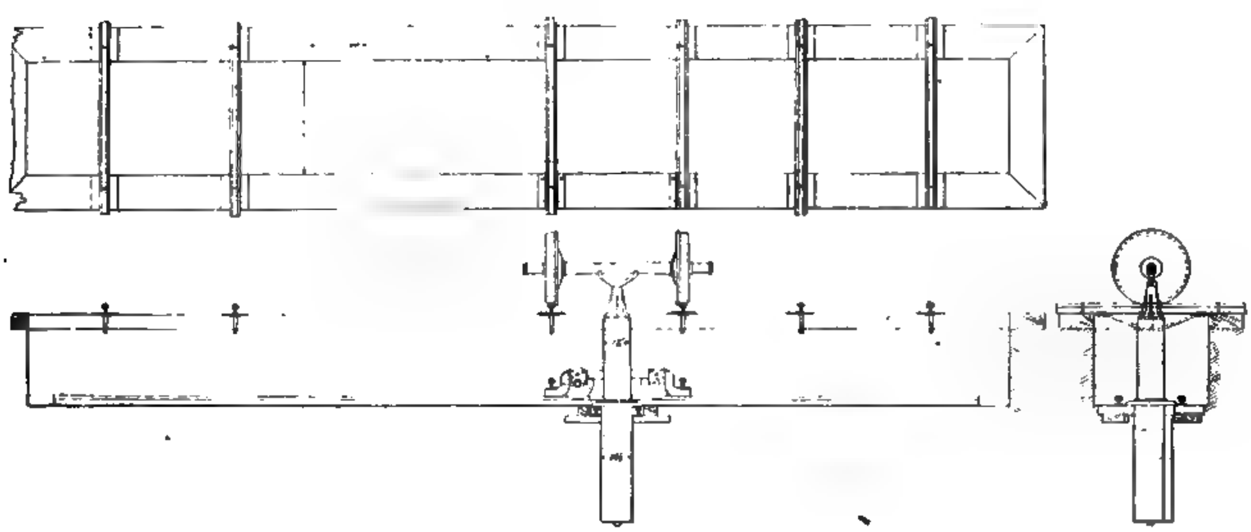
The Committee on Compressed-Air Appliances and Hydraulic Machinery sent out a circular of inquiry, and the answers received thereto showed that compressed air was used in car shops and yards for a great variety of purposes, such as jacks for lifting and lowering freight cars, drop pits for removing and placing car-wheels in trucks under all classes of passenger equipment, pneumatic portable jacks for lifting



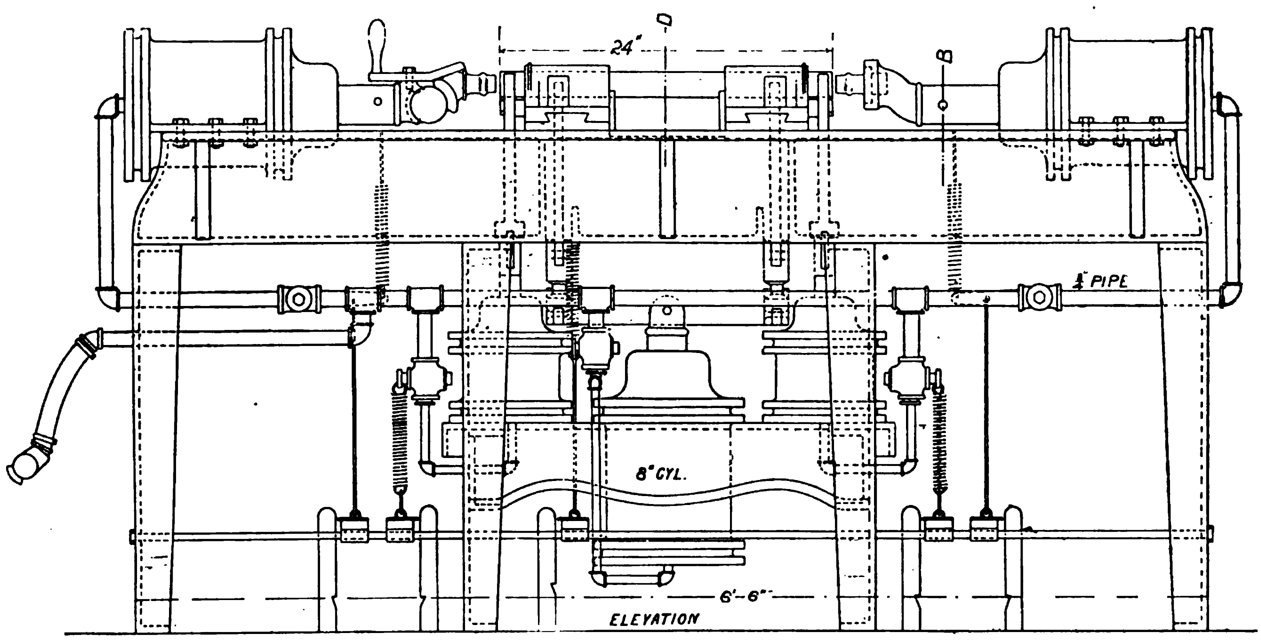
HOIST FOR LOADING AND UNLOADING CARS. TRUCK SHOP HOIST FOR LIFTING AND TURNING OVER TRUCKS. LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.



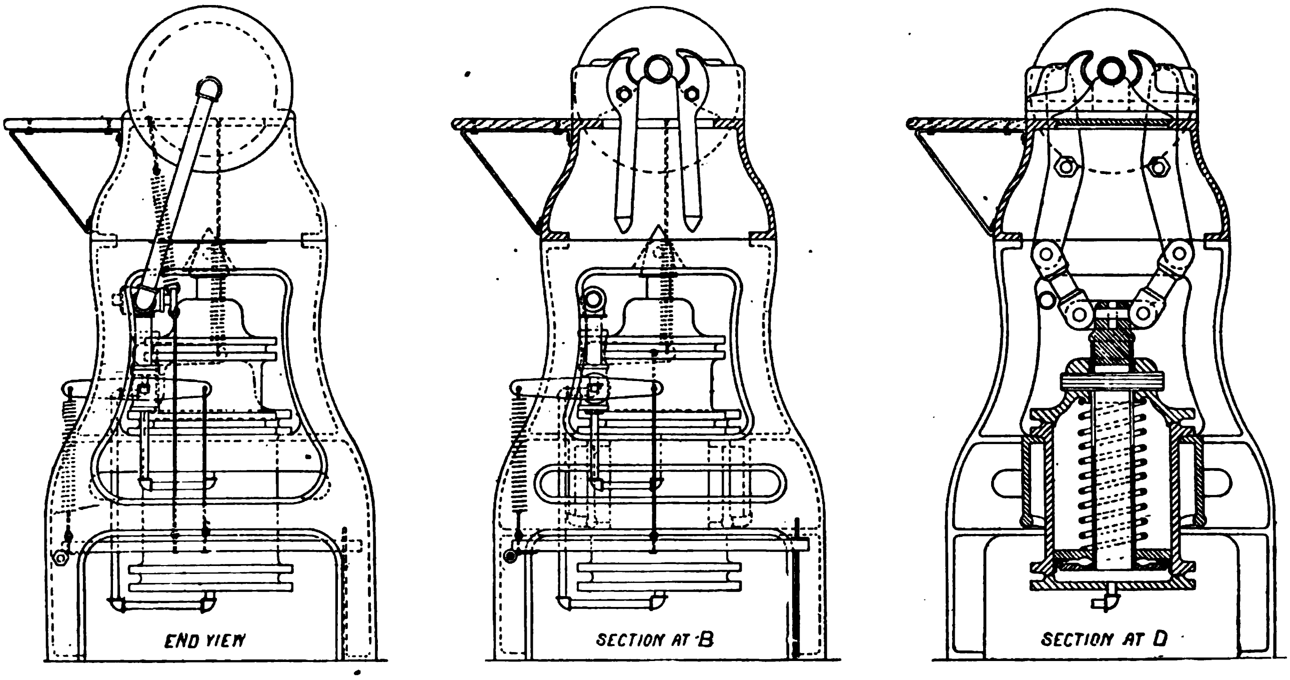
PIT JACK FOR WHEEL PIT. TELESCOPE JACK FOR WHEEL PIT. SHOP TRUCK JACK.
LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.



PASSENGER TRUCK DROP PIT, CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.



MACHINE FOR APPLYING AIR-HOSE FITTINGS, NORTHERN PACIFIC RAILWAY.



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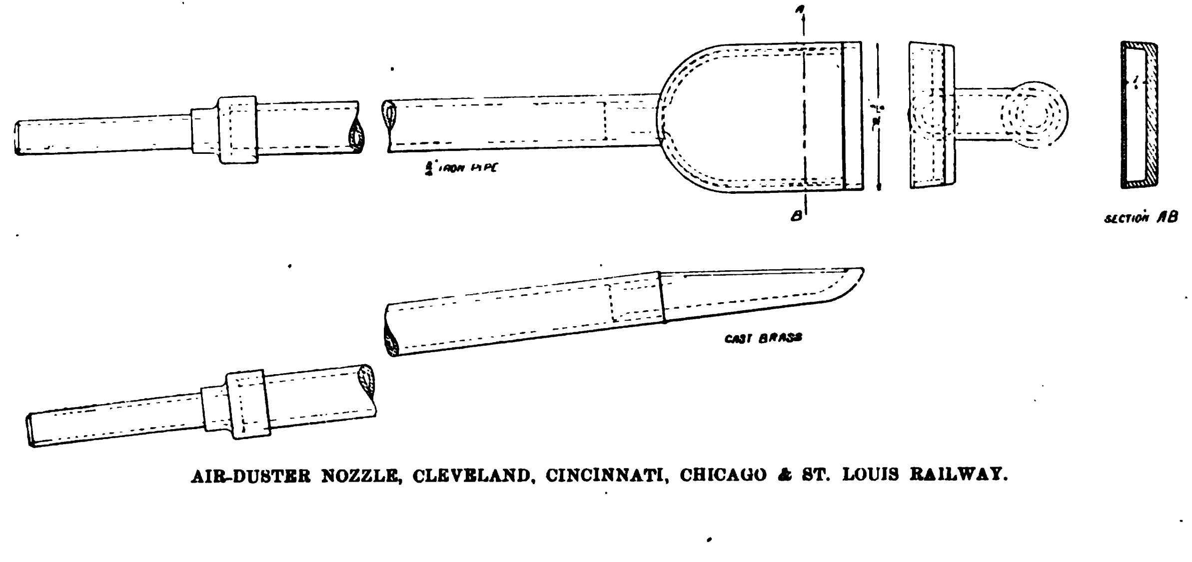
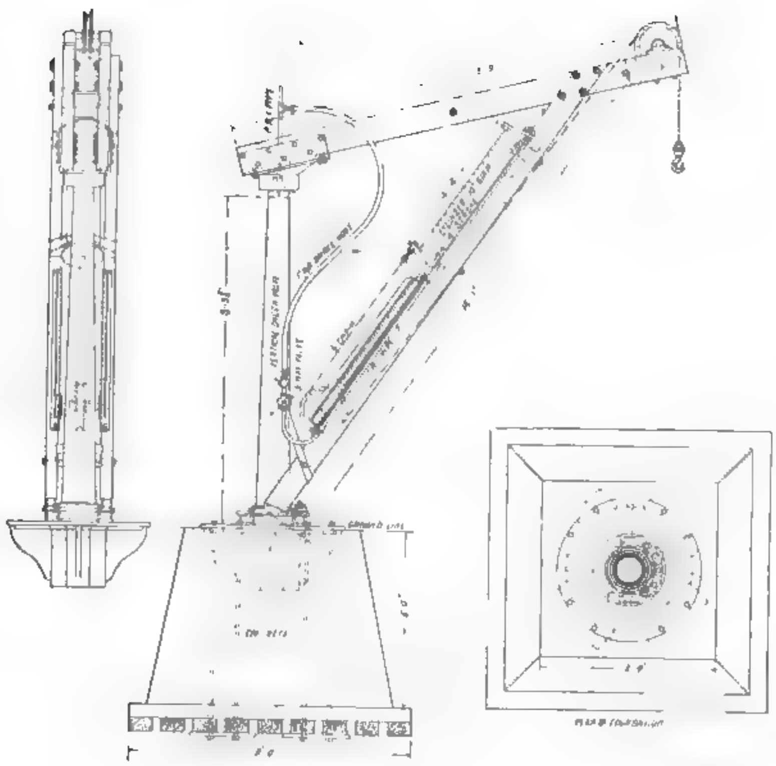
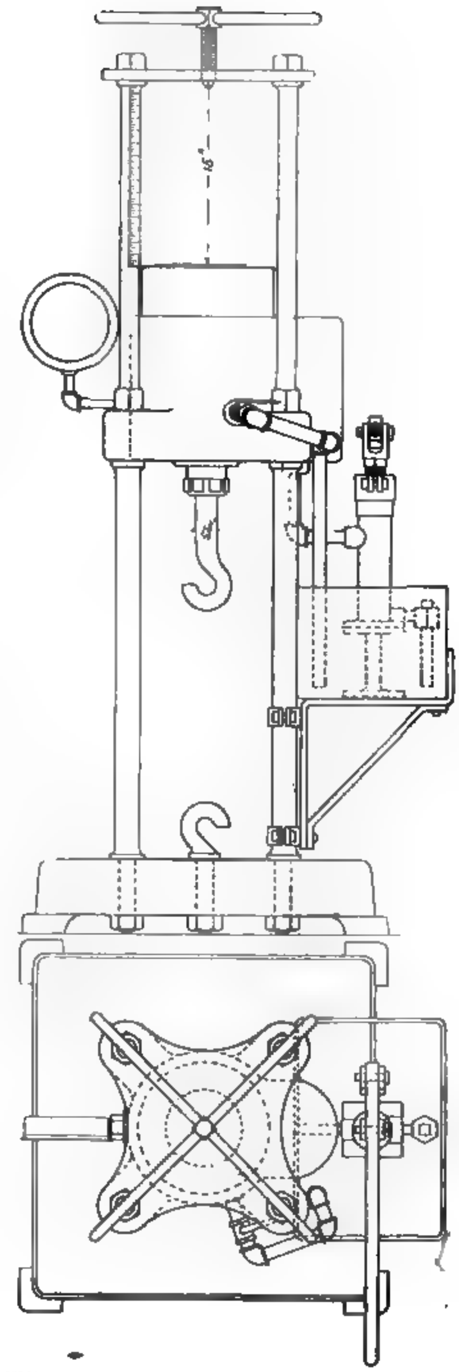


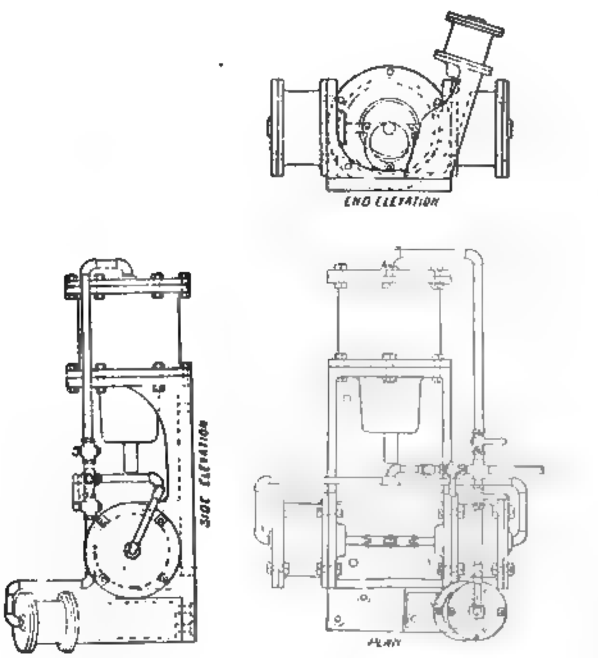
AIR-DUSTER NOZZLE, CLEVELAND, CINCINNATI, CHICAGO & ST. LOUIS RAILWAY.



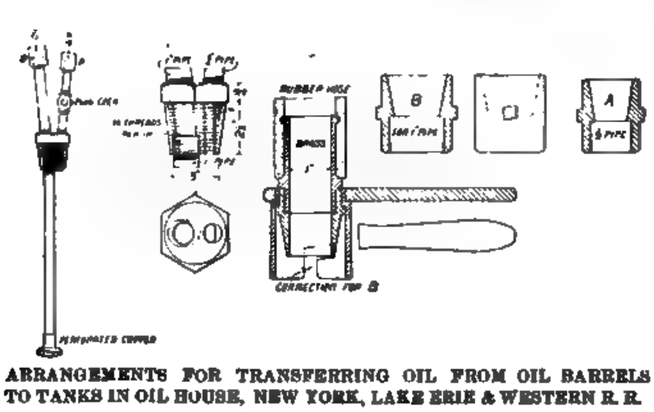
AIR HOIST FOR LOADING WHEELS AND AXLES, CLEVELAND, CINCINNATI, CHICAGO & ST. LOUIS RAILWAY.



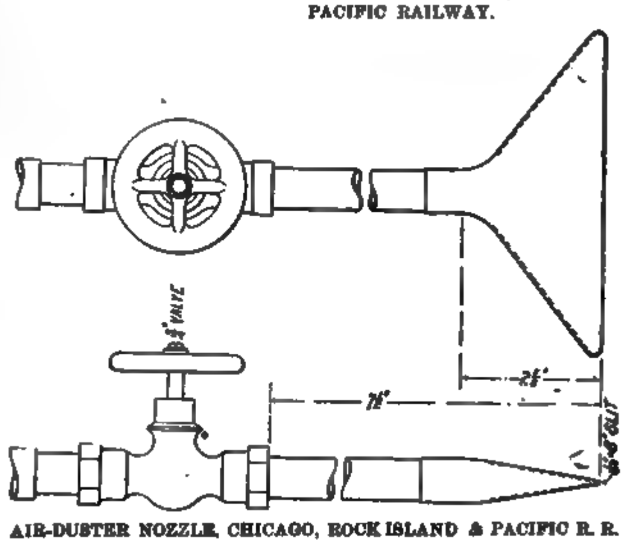
HYDROSTATIC TESTING MACHINE, NORTHERN PACIFIC RAILWAY.



PLAN FOR APPLYING HOSE CONNECTIONS. NEW YORK, PENNSYLVANIA & OHIO RAILROAD.



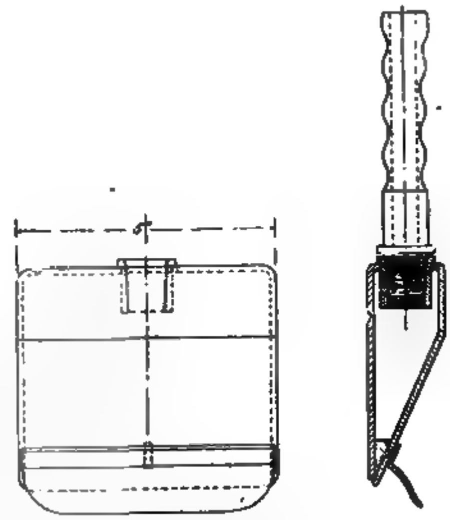
ARRANGEMENTS FOR TRANSFERRING OIL FROM OIL BARRELS TO TANKS IN OIL HOUSE, NEW YORK, LAKE ERIE & WESTERN R. R.



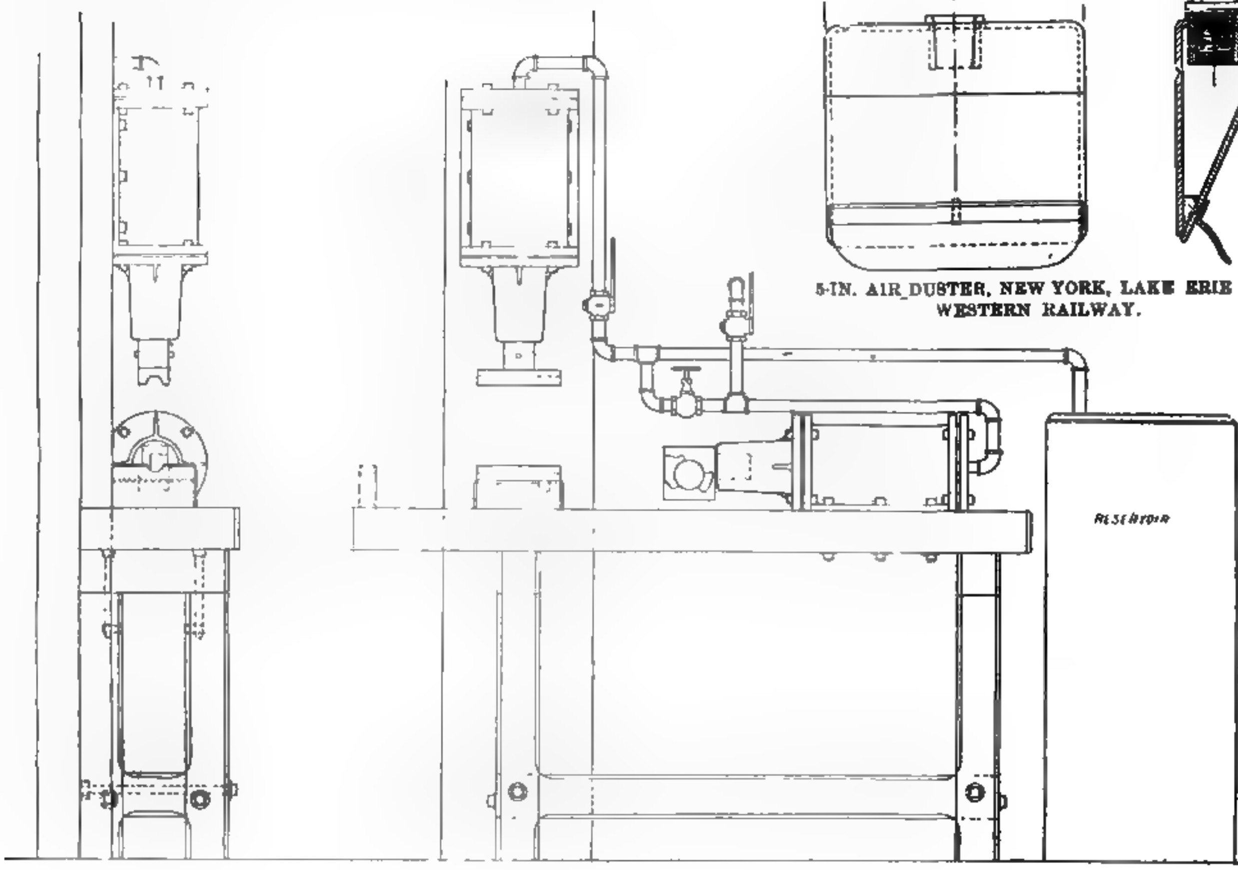
AIR-DUSTER NOZZLE, CHICAGO, ROCK ISLAND & PACIFIC R. R.

couplers into position, pull-down jacks for defective sills, needle beams and body bolsters, putting couplers on air brake hose, cleaning cushions, upholstery, carpets, etc., loading wheels and axles, lifts for machine tools, operating drills, rivets, transferring oil from the barrel to tanks, punches, testing air-brakes and sand-blasts for applying satin finish on silverware, car trimmings, etc The usual method of obtaining the pressure is by the employment of a locomotive air-pump.

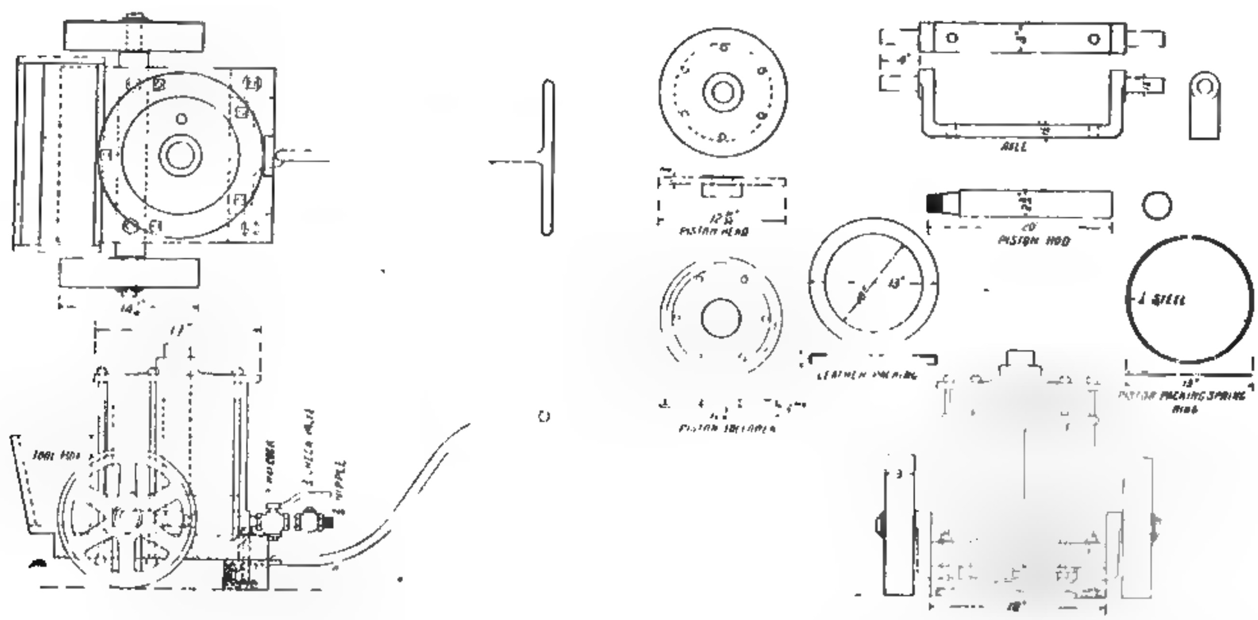
After reviewing the general conditions which must be ob-



5-IN. AIR DUSTER, NEW YORK, LAKE ERIE & WESTERN RAILWAY.



PNEUMATIC HOSE MACHINE FOR APPLYING HOSE COUPLINGS, ST. LOUIS SOUTHWESTERN RAILWAY.



13-INCH PNEUMATIC JACK, NORTHERN PACIFIC RAILWAY.

served in the application of compressed air to shop appliances, the committee recommends a few points to be observed when establishing air plants.

1. Arrange for the admission of cool air into the compressor, as the cooler the air can be taken in, the greater the economy in the cost of compressing.

2. Clean air, free from disagreeable odors, is desirable for cleaning purposes, and should be provided for at air-compressing plant.

3. It is advisable that the storage reservoir be placed at no great distance from the compressor, the principal reason being to lessen the liability of yard pipes freezing in cold weather. Proper provision should be made for drainage of pipes.

4. All pipes for conveying the air should be of sufficient size to prevent loss through friction, bearing in mind that they cannot be too large, as the volume of air contained therein represents that much increase in storage capacity.

5. To prevent moisture, dirt, and oil from passing into the air-using appliances, the inlet and outlet of compressed air in the storage reservoir should be separated as far as possible, and connection applied near top of reservoir, and a drainage plug provided at bottom for purpose of draining off accumulations of water, oil, etc.

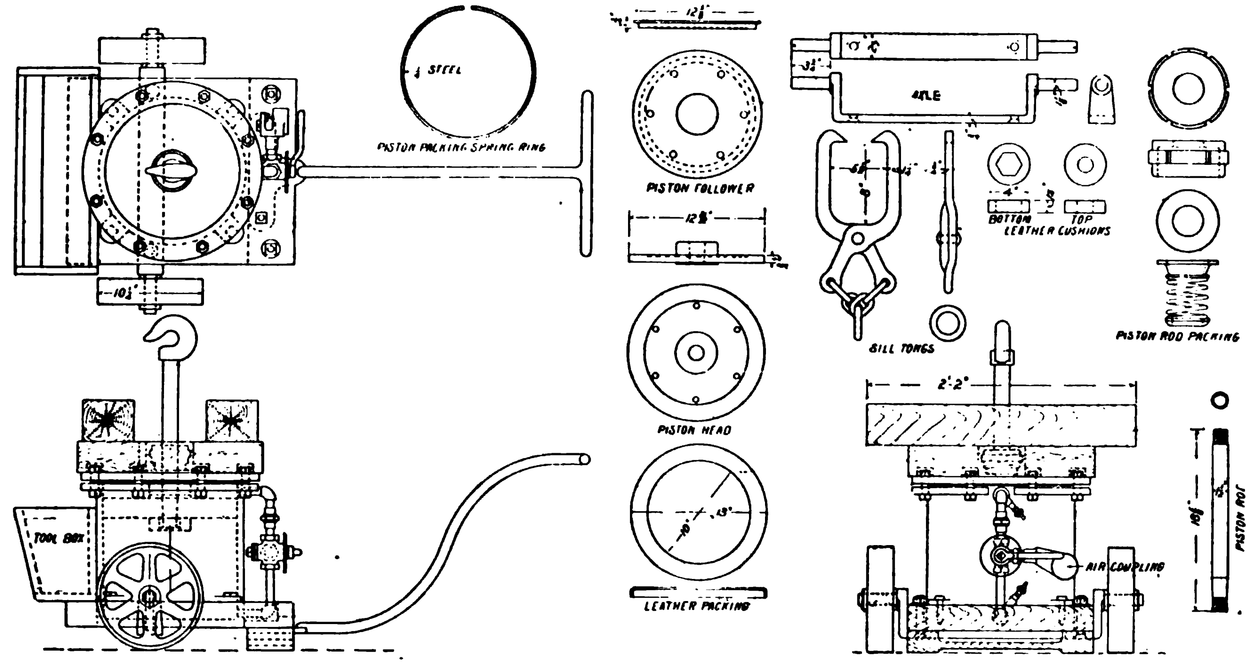
which we estimate would have taken the same labor from 30 minutes to 1 hour to have removed.

Several members report using pneumatic jacks for lifting and lowering purposes in car shops and repair yards, operated by a line of pipe leading from air reservoir, and located convenient to tracks, from which a hose connection to jack furnishes the air pressure required, and all report great economy resulting from their use over the present common screw and hydraulic hand jacks, a saving in some cases of 51¼ per cent.

Special attention is invited to the air appliances for applying fittings to air-brake and steam hose, especially machines similar to the one in use on the New York, Lake Erie & Western Railway, which is reported to your committee as performing the work it would take eight men to do by hand. Several other well-designed machines of this nature were described and reported as productive of great economy. Investigating these machines further, your committee finds :

1. You can use up all the rusty couplings, and you can apply an old coupling as easily as a new one. By hand it would be almost impossible to get an old coupling into some of the air hose.

2. It admits of having air hose made so that it will take



PULL-DOWN JACK FOR REMOVING CAR SILLS, NEEDLE BEAMS AND BOLSTERS, NORTHERN PACIFIC RAILWAY.

Explaining the value of compressed-air appliances, mentioned herein, it is reported to your committee that the pneumatic jacks or drop pits corresponding to those of the Lake Shore & Michigan Southern, and Chicago, Rock Island & Pacific Railway companies (as shown in cuts herewith) effect a saving of 47¼ per cent. in the work of changing wheels in passenger-car trucks. The devices for cleaning car cushions by air, shown by actual tests made by the committee, result in a very large saving. The average time consumed by two men (one operating a 5¼ cleaning nozzle, the other handling seats) in removing the dust from plush and springs of 200 seats, making them absolutely clean, was from 27 to 33 seconds to each seat. The air used in this test was supplied from a reservoir, and varied from 90 to 60 lbs. pressure. A similar test at cleaning by hand with common rattan beaters and brushing process by two men consumed from three to four minutes to each seat, effecting a saving of time in favor of cleaning by compressed air of 85 per cent.

The committee witnessed a test with pneumatic pulling-down jack in pulling down defective oak center sill from freight cars where the vertical bolts securing the same had become corroded, and would not yield to the blows of a heavy sledge-hammer. The pneumatic pulling-down was placed in position in two minutes, and sill pulled entirely loose at one end in 40 seconds ; the machine was again reset in two minutes, and the other end of sill removed in 30 seconds, making 5 minutes and 10 seconds to remove center sill by two men, from 20 to 30 lbs. pressure to apply couplings, and by so doing you do not require to depend so much on the band or clamp for securing hose on coupling, thereby reducing the liability of hose blowing off of coupling when in service, causing delay, etc.

3. With one or two of these machines located at convenient points on a system, all of the hose can be fitted up where machines are located, which would concentrate the stock, consequently doing away with the necessity of other repair points carrying this material, effecting a large saving on account of not accumulating a surplus stock.

The novel and satisfactory feature of whitewashing a roundhouse, as reported by the Chicago, Burlington & Quincy Railroad Company, and one or two other roads, by placing liquid lime in a small reservoir and charging the same with compressed air and applying the whitewash by means of hose and spray nozzle, we believe could be successfully employed with saving results for rough structures about a car-shop plant or yards, and the subject is worthy the consideration of the members.

It was reported by the manufacturers of air appliances that superheated compressed air used in air lifts, jacks, engines, etc., increases the efficiency fully 50 per cent., but your committee was unable to make test or procure reliable data on the statement which would be of value in deciding the question as to cost, feasibility, and economy in its use.

A large number of compressed-air appliances are located

LOCOMOTIVE RETURNS FOR THE MONTH OF MARCH, 1894.

Name of Road.	Number of Serviceable Locomotives on Road	Number of Locomotives Actually in Service.	Locomotive Mileage.					Av. Train.		Coal Burned per Mile.						Cost per Locomotive Mile.							Cost per Car Mile.		Cost of Coal per Ton.
			Passenger Trains.	Freight Trains	Service and Switching.	Total	Average per Engine.	Passenger Cars.	Freight Cars.	Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Passenger.	Freight.	
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Atchison, Topeka & Santa Fé	844	758	...	...	...	1,976,707	2,608	...	...	...	...	...	87.68	...	...	5.21	7.69	0.20	0.22	6.61	1.55	21.48	...	...	1.69
Canadian Pacific	603	...	492,906	652,095	258,906	1,403,907	2,328	...	...	...	...	...	72.89	...	...	5.19	11.05	0.35	...	5.75	1.45	23.79	...	...	3.03
Chic., Burlington & Quincy	541	...	...	...	...	1,385,098	2,560	4.72	19.75	...	...	...	86.18	...	...	5.05	5.98	0.20	0.24	6.82	0.04	18.28	...	...	1.82
Chic., Milwaukee & St. Paul	855	...	...	...	...	2,001,056	2,840	...	...	...	...	...	78.61	...	...	4.11	7.18	0.28	...	6.91	...	18.48	...	...	2.38
Chic., Rock Island & Pacific	564	...	479,550	923,679	310,715	1,718,944	3,039	5.20	1.78	57.20	75.84	41.14	64.83	11.17	4.63	1.79	5.98	0.24	...	6.25	0.41	14.67	...	...	2.16
Chicago & Northwestern	1010	...	803,244	1,324,365	552,565	2,680,174	2,653	...	...	...	...	...	90.01	...	...	3.49	8.25	0.89	...	6.28	0.88	19.20	...	...	1.82
Cincinnati Southern	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cumberland & Penn.*	23	23	5,772	27,745	...	33,517	1,457	...	...	...	...	...	87.21	...	...	5.68	4.68	0.35	...	...	1.91	12.63	...	...	
Delaware, Lackawanna & W. Main L.	212	171	72,572	200,393	272,869	545,834	3,192	...	...	...	...	...	86.80	...	...	2.87	7.00	0.48	...	5.62	...	16.12	...	...	1.60
Morris & Essex Division	162	...	184,471	151,806	82,141	418,418	2,582	...	...	...	...	...	71.35	...	...	3.89	11.18	0.37	...	6.34	...	21.23	...	...	3.09
Hannibal & St. Joseph	67	67	...	...	...	237,259	3,650	4.60	17.13	...	...	...	83.09	13.63	6.65	3.46	5.40	0.11	0.35	7.03	0.02	16.87	...	...	1.38
Kansas City Ft. S. & Memphis	145	...	94,378	218,982	86,769	400,129	2,759	...	...	...	...	...	68.59	...	...	2.97	5.87	0.23	0.41	7.39	...	16.37	...	...	1.52
Kan. City, Mem. & Birm	42	37	35,536	52,537	11,606	99,679	2,694	...	...	...	...	...	67.98	...	...	3.63	3.90	0.26	0.52	7.04	...	15.15	...	...	1.08
Kan. City, St. Jo. & Council Bluffs	37	37	...	...	...	131,655	3,558	4.87	23.12	...	...	...	74.07	14.36	4.60	3.00	7.11	0.18	0.68	6.80	0.02	17.79	...	...	1.90
Lake Shore & Mich Southern	592	...	429,568	833,812	400,709	1,664,089	3,157	...	...	60.44	93.10	38.84	71.33	...	...	2.93	5.24	0.05	0.12	6.77	0.15	15.26	...	...	1.46
Louisville & Nashville	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Manhattan Elevated	...	296	777,741	...	69,489	847,230	2,862	...	...	...	...	...	48.39	...	...	2.30	8.70	0.20	...	9.00	...	20.20	...	...	3.99
Mexican Central	148	126	...	...	...	447,543	3,552	...	...	...	...	...	68.49	...	...	5.01	12.24	0.42	...	4.51	0.09	22.27	...	...	3.92
Minn., St. Paul & Sault Ste. Marie	104	78	78,610	132,726	22,696	234,032	20.000	4.96	20.17	...	...	...	76.86	...	5.18	4.26	12.93	0.25	...	6.55	...	23.99	4.09	1.39	3.33
Missouri Pacific	851	...	...	...	...	940,005	3,333	4.39	16.98	...	...	...	87.22	...	...	5.22	6.19	0.30	1.40	6.24	1.46	20.81	4.16	1.49	1.39
Mobile & Ohio	107	87	77,216	159,869	57,810	294,895	3,389	...	...	...	...	...	65.72	...	...	2.99	4.71	0.22	0.59	5.78	0.90	15.14	...	...	1.43
N. O. and Northeastern	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
N. Y., Lake Erie & Western	634	387	435,921	732,184	239,618	1,407,723	3,638	4.30	23.70	88.50	136.80	78.50	101.23	20.70	5.80	4.42	7.71	0.37	2.20	7.34	1.31	23.35	...	...	1.37
N. Y., N. H. & H., Old Colony Div.	...	...	369,211	146,089	167,389	683,835	...	3.80	17.60	...	...	...	66.42	18.00	5.40	3.48	9.98	0.57	...	7.29	0.76	22.08	...	...	...
N. Y., Pennsylvania & Ohio	274	157	127,702	366,911	117,686	612,299	3,899	5.20	19.70	69.30	111.90	148.55	108.25	12.40	5.70	4.49	5.02	0.31	2.52	7.00	1.15	20.49	...	...	1.04
Norfolk & Western, Gen. East. Div.†	...	...	93,834	283,938	50,911	428,683	2,713	4.92	21.24	50.50	126.40	...	88.45	10.20	5.90	5.89	3.61	0.31	...	...	...	9.81	...	...	3.80
General Western Division†	...	...	98,018	324,702	52,008	474,723	2,601	5.59	17.34	80.00	136.00	...	127.00	14.34	8.37	7.27	4.21	0.25	...	...	...	11.78	...	...	...
Ohio and Mississippi	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Philadelphia & Reading	...	...	429,677	305,231	752,999	1,487,907	...	...	...	...	...	...	82.67	...	...	4.83	4.59	0.26	...	5.73	0.47	15.58	...	...	...
Southern Pacific, Pacific System	725	646	682,927	747,020	257,041	1,686,988	2,611	5.66	18.90	...	...	...	70.27	...	...	5.55	16.20	0.21	1.99	7.24	1.21	33.30	...	...	4.80
Union Pacific	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Wabash	418	334	429,517	590,640	202,155	1,222,312	3,659	4.55	17.05	69.08	105.04	61.96	85.72	15.17	6.15	3.08	4.84	0.26	...	6.08	0.89	15.14	2.92	1.01	1.16
Wisconsin Central	149	94	116,409	168,802	45,425	325,636	3,464	...	...	...	...	...	81.10	...	...	2.60	9.25	0.15	...	7.08	...	19.08	...	...	2.25

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars. Empty cars which are reckoned as one loaded car are not given upon all of the official reports, from which the above table is compiled. The Union and Southern Pacific, and New York, New Haven & Hartford rate two empties as one loaded; the Kansas City, St. Joseph & Council Bluffs and Hannibal & St. Joseph Railroads rate three empties as two loaded; and the Missouri Pacific and the Wabash Railroads rate five empties as three loaded, so the average may be taken as practically two empties to one loaded.

* Switching engines allowed 6 miles per hour; wood, construction and gravel trains, 10 miles per hour.

† Wages of engineers and firemen not included in cost.

out of doors under circumstances where water used in hydraulic machinery would not be economical to maintain on account of freezing, and the committee therefore decided that hydraulic machinery does not possess as many advantages for car repairs and construction purposes as compressed-air appliances. This part of the report occupies the first four pages, and the remaining 19 are used in illustrating the various pneumatic and hydraulic appliances, drawings of which were sent to the committee. Some of these drawings have already been published in THE AMERICAN ENGINEER AND RAILROAD JOURNAL. Among them we would cite the hydraulic lift used at the Oneonta shops of the Delaware & Hudson Canal Company, and published in our issue of April, 1893. The hydraulic-car lift is similar, except in a few unimportant details, to the locomotive lift published in July, 1893; the hydraulic wheel-crane published in April, 1893; the hydraulic jack for car shops, of December, 1893. In addition to these there was a 12 in. air hoist of the Chicago, Burlington & Quincy Railroad, and a similar one of the Minneapolis, St. Paul & Sault Ste. Marie Railway, which are in every respect similar in detail and construction to those published in our issue of February, 1894, illustrating the ones used at the shops of the New York, New Haven & Hartford Railroad, at New Haven, Conn.

The other appliances given in the report of the committee consisted of a hoist for loading and unloading cars of the Lake Shore & Michigan Southern Railway, a pit jack, telescope jack, and shop-truck jack of the same road; a passenger-car truck drop-pit of the Chicago, Rock Island & Pacific Railway; a pull-down jack for removing car cylinders of the Northern Pacific Railway; a 13 in. pneumatic truck jack on the same road; a pneumatic hose machine for applying hose couplings on the St. Louis & Southwestern Railway; 5-in. air duster nozzle of the New York, Lake Erie & Western; a similar nozzle of the Chicago, Rock Island & Pacific Railroad, and also an air duster of the Cleveland, Cincinnati, Chicago & St. Louis Railway. The plan for applying hose connections of the Pennsylvania & Ohio Railroad is also given, and the hose couplings for transferring oil from the oil barrel to the tanks and oil house of the New York, Lake Erie & Western; an air hoist for loading wheels and axles of the Cleveland, Cincinnati, Chicago & St. Louis Railway; a hydraulic testing machine of the Northern Pacific, and a machine for applying air hose fittings of the same road. These illustrations are reproduced herewith.

The committee on automatic coupler standards and limits made an elaborate report on the method of conducting the coupler tests both at the Watertown arsenal and at Altoona, giving data in regard to the shipping directions and general conditions of the test, which are already familiar to our readers. One feature, in addition to the direct tensile test which was made at Watertown, and the drop test as usually conducted at Altoona, is the newly introduced jerk test, in which an attempt was made to reproduce as nearly as possible the strains which are put upon a coupler in starting a heavy train, or such as will occur at sudden changes in the grade. In this test two draw-bars were used. They were inverted and placed in the machine together, suspended from pedestals by tail bolts and yokes and freight draft springs, allowing 1¼ in. between striking points, and held in position as arranged for in the construction of the machine. A weight of 1,640 lbs. was dropped on an equalizer bar connecting the two couplers. Three blows from a height of 5 ft. and three blows from a height of 10 ft., the blows being continued from a height of 15 ft. until the coupler was destroyed or rendered unserviceable. The results of these tests showed that 16 per cent. of the shanks cracked and broke behind the head, 26 per cent cracked and broke in the head and 44 per cent. of the knuckles were broken. In the opinion of the committee these tests should be considered as furnishing independent information from drop tests made on a solid foundation. It is acknowledged, however, that it is open to criticism as being artificial; but without it there would be little information obtainable as to the efficiency of locking devices.

The result of this test conflicts with the observation of service, for whereas in actual service there is a preponderance of guard arm failures, in the test the shank failures are in excess. The probable explanation is that direct blows concentrate the shock on the opposite side of shank, whereas a glancing blow or one from a broken link and pin coupler wedges off and breaks the guard arm alone.

The committee stated that before endorsing the recommendations made in the report of 1892, they would call attention to the necessity of the revision of the dimensions of the shank immediately behind the head, stating that while larger fillets would accomplish good results, they believed, at the same time, a more satisfactory design would be the widening of the shank for short distances together with the introduction of larger fillets. The committee have also called attention to the indifference displayed toward the M. C. B. contour lines. Out of 114 couplers presented, representing 25 different kinds, but 20 couplers fully complied with the M. C. B. limit gauges.

In regard to locking device your committee is at a loss to recommend anything that would be of value. It has been impossible to assimilate the many different types presented. This must be the work of future investigation. It has only to say that the results show that locking devices are efficient in proportion to their simplicity.

The committee hesitated in recommending the material to be used for couplers. The result shows that the strongest coupler, all other things being equal, will no doubt be made of steel. The worst steel bar, however, is not as good as the best malleable iron bar, although the best steel bar is superior to the best malleable iron bar, and the poorest steel bar is better than the poorest coupler made of malleable iron. It does not follow, however, that the use of malleable iron is to be condemned for the reason that your committee does not believe that strength alone is the all-important item. Few structures, involving expenditure of money, are designed to do more than is required of them with the proper safety factor. A coupler of steel or one of malleable iron may be made so heavy and so large as to be practically indestructible, and at the same time it would be neither cheap in first cost nor satisfactory to use. Future developments would seem to be in the line of making a coupler as light as possible, and sufficiently strong to meet the strains to which it is subjected, of as cheap material as is consistent with the above; and the coupler which will have the highest commercial value will be the one which combines the elements "minimum weight," "minimum first cost," "the greatest average strength," and "the most perfect yet simple action." In addition to this we must consider also the cost of renewals of couplers which have failed in service.

The Secretary of the Association made the report of lighting passenger car equipment on account of the fact that the committee were not prepared to render a report. His report consists of a compilation of statements from various roads which are using Pintsch gas, Frost light and electricity. Of these, ten roads and the Wagner and Pullman Palace Car Company report that they have either adopted the Pintsch light or are equipping cars with them as rapidly as possible. The Pullman Company report that it is a great saving in the matter of carpets and upholstery, as oil lamps leak more or less and injure them. The New York, Ontario & Western Road report that all cars that are being generally repaired are equipped with the Frost light; other roads do not mention at what rates the introduction of this light is being extended. Eight roads report having used electricity, but only two, the Pennsylvania and the Chicago, Milwaukee & St. Paul, are continuing its use, the others having abandoned it almost entirely on account of expense, and the Chicago, Milwaukee & St. Paul arrangements are those of an independent dynamo under the designs of Mr. Gibbs. With this system the cost of running light is estimated at $.88 per car per day when figured on a seven-car train; but if a longer train were taken the cost per car would be somewhat less as the allowance for attendance would be the same.

The final work of the convention was transacted on Friday morning with the continuation of a discussion on the interchange rules and the adoption of the other resolutions of thanking the various parties who had rendered courtesies to the members of the convention.

On Sunday evening a memorial service was held in the parlor of Congress Hall to Mr. Joseph K. Bole, of the American Steel Casting Company. A short tribute was read and resolutions of sympathy and appreciation passed. Similar resolutions were also adopted regarding Robert Ross, who was killed at the last city elections at Troy, N. Y., of Mr. Alfred Reed Slack and Major John C. Paul.

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

THE object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publication will in time indicate some of the causes of accidents of this kind, and help to lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with information which will help to make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a

favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we all intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in May, has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS FOR MAY.

Parnassus, Pa., May 3.—A collision occurred at Johnstown on the Allegheny Valley Railroad this morning, between a gravel train and an accommodation train. The engineer and fireman escaped with slight bruises.

Birmingham, Ala., May 6.—A south-bound freight on the Louisville & Nashville Railroad was wrecked at Wilhite this morning. Engineer William Whitman was instantly crushed to death, and his fireman, Joe Orr, seriously injured. The cause of the accident was that the freight train ran off the end of a stub switch, when the engine left the track and rolled down a 10-ft. embankment.

West Plains, Mo., May 7.—A freight train ran into a bunch of cattle near Brandsville this morning. The engine and six cars were derailed and wrecked. Engineer Kelsey jumped, but was caught by a car and was literally cut in two.

Tomsville, Ky., May 8.—George Patrick, an engineer on the Louisville & Nashville Railroad, committed suicide to-day on account of an accident to his train about a month ago. The engine collided with another on account of an order he had forgotten, and slight damage was done to both locomotives; no one was injured. He had been in the railroad service for 40 years, and this was his first accident. He was dismissed on account of being considered untrustworthy, and became so worried over it that his mind was unbalanced.

Gilman, Ill., May 9.—A northern express on the Illinois Central Railroad was wrecked at Buckley, 9 miles from here to-day, by the train breaking in two. Engineer Samuel Edgerly was killed almost instantly.

Davisville, R. I., May 10.—There was a rear-end freight collision at this point on the Stonington Division of the New York, New Haven & Hartford Railroad this morning. Engineer A. R. Wilson and Fireman W. B. Bogue sustained slight injuries from jumping. The headlight of the locomotive coming in the opposite direction dazzled the eyes of the engineer, so that they did not see the signals of the train into which they ran.

Menominee Junction, Wis., May 10.—A head-end collision occurred between a passenger train and a freight train on the Chicago & Northwestern Railroad to-day. The fireman had both legs cut off, and died soon afterward. The engineer was also killed.

Hammond, Ind., May 12.—The Monon passenger train from Louisville was wrecked 3 miles east of here this morning. Bridge workmen who left a switch open after passing with a hand-car are responsible. David Pope, the engineer, was injured.

Wilhite, Ala., May 18.—An engine was derailed by an open switch at this point to-day, and Engineer Whitman was killed.

Springfield, Mass., May 19.—The Adams express train from New York to Boston ran into an open switch below Elm Street on the New York, New Haven & Hartford Railroad just before 3 o'clock this morning, and crashed into a freight train back of the freight office. The express locomotive was damaged and freight cars were derailed. The engineer and fireman were slightly injured.

Princeton, Ky., May 19.—A collision occurred in Standing Rock tunnel on the Newport & Mississippi Valley Road to-day. The engineer and fireman jumped and escaped with slight injuries.

Effingham, Ill., May 20.—Passenger train No. 24 of the Illinois Central was wrecked to-day at Watson, 5 miles south of this city. Heavy timbers were wedged into the frogs of the switch at the south end, and a freight train had headed for the switch to let No. 24 pass. When the locomotive of the passenger train reached the obstruction it left the track and ran against the freight locomotive. Fireman Charles Walters of the freight engine was painfully injured, and George Baker of the passenger engine was also hurt.

Bordentown, N. J., May 22.—An extra coal train was wrecked at West Palmyra, on the Amboy Division of the Pennsylvania Railroad, this morning, by a washout. Engineer Fine was seriously injured.

Galesburg, Ill., May 25.—A lubricator glass in an engine on the Chicago, Burlington & Quincy Railroad broke at this point, and 3 qts. of kerosene were spilled through the cab. Fireman Ed. Martin was set on fire, and with flaming clothes rushed to the water tank and jumped in, extinguishing the flames. Engineer Giddings, after stopping his train, leaped from his engine and rolled around on the wet grass. The fireman's clothes with the exception of his undershirt were destroyed. He was horribly burned, and is in a precarious condition.

Aurora, Ill., May 24.—A fast train on the Chicago, Burlington & Quincy Railroad ran through an open switch near here last night. Fireman Ridgerley was fatally injured.

East Liverpool, O., May 24.—A collision occurred on the Cleveland, Akron & Columbus Railroad this morning between a freight and passenger train. Engineer James Johnston had his kneecap seriously injured, and Fireman Paisley sustained severe injuries. The other engineer and fireman escaped with slight injuries.

Philadelphia, Pa., May 24.—There was a collision between a Pennsylvania and Reading locomotive at Powelton Avenue this morning. The Reading engine was turned over, and Thomas Ryan, the fireman, was badly scalded about the head, neck, and arms. Thomas Roche, the engineer, jumped and escaped with slight injuries.

Aquilla, Tex., May 25.—An engine and six cars of a freight train on the Texas Central Railroad jumped the track here to-night. Engineer John Elliot was crushed beneath the *débris*.

Tyler, Tex., May 25.—While Engineer Frank Gurr with two assistants was testing a new locomotive on the Cotton Belt Line to-day, it jumped the rails and rolled down an embankment. All three men were fatally scalded.

North Yakima, Wash., May 27.—Back water from the Yakima River undermined a small bridge on the Northern Pacific Railroad 19 miles east of here this morning, and a freight train crashed through the bridge. Engineer Worth jumped, but was badly crushed.

Cumberland, Md., May 27.—An express train on the Baltimore & Ohio Railroad ran into a landslide 7 miles east of here this morning. Fireman Rhinehart was buried beneath the locomotive, as was also Engineer Nicholson. Both of them were killed and their bodies badly burned.

Salt Lake, Utah, May 29.—A work train on the Union Pacific collided with a passenger train near Castle Rock to-night, killing Engineer James.

Sharon, Mass., May 30.—As a berry train on the Old Colony Railroad was passing this point this morning, it crushed into some freight cars left on the north-bound track by the local freight train. The locomotive was somewhat damaged. The fireman, Edw. T. Goodwin, was scalded to death.

Milwaukee, Wis., May 30.—A through train for Chicago on the Wisconsin Central Railroad was wrecked early this morning at Mandville. A split switch had been tampered with, allowing the wheels of the locomotive to catch the point. James Hubbard, an engineer, and George Gearhart, fireman, were killed.

Our report for May, it will be seen, includes 24 accidents, in which 11 engineers and 6 firemen were killed, and 12 engineers and 10 firemen were injured. The causes of the accidents may be classified as follows:

Break in two	1
Bursting gauge-glass	1
Cattle on track	1
Collisions	8
Derailments	2
Landslide	1
Misplaced switches	6
Suicide	1
Train wrecking	1
Washouts	2
Total	24

SOME EXHIBITS AT THE CONVENTIONS.

The Committee of Arrangements made the best preparations for the reception and display of exhibits that have yet been made. Mr. Clements, of Congress Hall, threw the back piazzas of his hotel open to all exhibitors free of charge provided they were guests of his house; if they were not, a small charge was made. An engine with boiler was provided, together with a line of shafting in motion from which power was taken for one or two devices. There was also a Westinghouse air pump providing air pressure for those who wished to avail themselves of it. Among those were sanding and ventilating devices and the Kinsman system of block signaling. Among the exhibits we selected the following as being especially worthy of mention:

L. C. Chase & Company made a more elaborate display at this convention than any previous one of the mohair car plushes

which they manufacture. These plushes are made at the Sandford Mills, of Sandford, Me. The especial features were the displaying of figured or frieze plushes, which are so generally used in parlor and sleeping car work, as well as the extra high plushes in all colors for the same purpose. The L. C. Chase Company's usual grade of low-pile plushes for the ordinary passenger coach work was shown in great variety of colors and in widths of 24 in. and 28 in. The framed specimens of the material which enters into the manufacture of plush attracted especial attention. This was arranged so that it showed the different stages through which the mohair passes from its crude state when taken from the Angora fleece to the completed state after spinning. There were also some fine specimens of crushed plushes. The exhibit was in charge of R. R. Bishop, Jr. It is worthy of notice that at the recent World's Fair at Chicago these plushes received five first medals and five diplomas, which was practically a sweepstake over other competitors.

The Consolidated Car Heating Company made an elaborate display of the several devices which they use in connection with their steam-heating appliances. The display of this company has always attracted a great deal of attention at previous conventions. They heretofore have had a working model of their apparatus, showing the various systems of direct circulation and commingler heating which are installed by them. They have, however, rendered this work so familiar that their models were wanting in this year's exhibit, but have been amply compensated for in the details which they have displayed. These details consisted of a large number of photographs and drawings of their work, together with samples of the new electric car heater which they are introducing, and which was thoroughly illustrated in our issue for June, 1893. This company has also recently made an arrangement for the introduction of the Pope compressed system of car lighting into this country. This system has been extensively introduced in England, and the exhibits consisted of a large number of special fittings with photographs of the application to cars with plans of the various compressing plants that are in use in England. Owing to the fact that the drawings and photographs were required at Saratoga until the last minute, we have been unable to reproduce them in this issue, but in our issue for August we expect to publish a complete description of the Pope system of lighting cars with compressed air.

Crosby Steam Gauge & Valve Company.—The display of this company, which has been for several years under the personal supervision of Mr. Edward C. Bates, always attracts a great deal of attention, not only on account of the arrangement, but of the beauty of the finish of the several instruments exhibited. This year they exhibited a vacuum test pump which is constructed with a mercury column, and is so arranged that it reaches a 28 in. vacuum with a very few strokes of the pump. Their gauge-testing machine with positive weights was also in evidence. This is a very simple device, and is one which the company has had upon the market for a number of years. Their steam-engine indicator had an attachment which is somewhat of a novelty, being Sargent's electrical attachment, so that any number of simultaneous cards may be taken at the same time by the closing of one indicator point. They also showed Johnstone's blow-off cock, which was designed by Mr. F. W. Johnstone, of the Mexican Central Railway, and which is kept closed by water pressure, and first blows out at the bottom and clears away all scale. It is operated with a direct pull, and seats itself. They also showed locomotive gauges with black face and white figures and white face with black figures, together with bromide enlargements of photographs of their supplies and of their World's Fair exhibit. In addition to these there were the water glass attachments and self-closing water glass cocks with a ball held in suspension by wires, which is pushed back by the valve, so that there is no danger of the closing ball becoming covered by scale and thus failing to close in case the water glass breaks. There were also muffled safety valves and plain Crosby valves, together with a syphon attachment for steam gauges. This latter is especially worthy of attention because it supplies an ample water leg below the gauge, and thus ensures water contact in the Bourdon spring at all times. Too much stress cannot be laid on the importance of proper syphoning of steam gauges, because when this is not done the direct heat from the steam will ruin the spring of the gauge in a short time. There was also a very neat design for a hot well thermometer.

The A. French Spring Company had samples of their half elliptic driving springs, and in connection with the Morris Box Lid Company showed the Morris box lid cover for oil boxes. Mr. Morris has also recently designed a steel cover for air brake hose which effectually covers the opening against any extraneous matter, and allows it to hang down or to be hooked up as with a dummy coupling if desired.

Kinsman Block System Company had a full-sized model exhibited of their apparatus, which was illustrated in the June issue of this paper. In connection therewith there was a short length of model track with trucks thereon, which could be run backward and forward, making the electric connections and applying the brakes. This exhibit attracted a great deal of attention on the part of all railroad men present; and the consensus of opinion was that it was not only decidedly novel, but very effective. For a full description of the apparatus we would refer our readers to our June issue.

The Ross Valve Company exhibited a rack with a full line of their reducing valves, together with blow-off valves. This exhibit was particularly attractive from the neatness and taste with which it was gotten up.

William C. Baker had a car heater on exhibition with the special appliances that are attached thereto, to which more particular reference is made in a special article in another column of this paper.

Simonds' Rolling Machine Company exhibited pins for brake connections and signals, staff bands, boiler patch bolts and track bolts. All of this material is rolled, and even the square heads attached to the boiler patch bolts, which are intended for breaking off, are rolled by their process.

Safety Car Heating & Lighting Company had their usual exhibit of Pintsch gas in operation. It consisted of a rack containing a tank of compressed gas with the regulating apparatus together with the cocks and lamps in operation. The light was very brilliant, and, inasmuch as it was located in a prominent position in the office of the hotel, attracted a great deal of attention.

Taylor Iron & Steel Company exhibited two of their manganese steel car wheels which had been subjected to a very severe drop test. These, we believe, were the same which were on exhibition at Lakewood one year ago, and which excited so much interest at that time.

Westinghouse Air Brake Company had a truck on exhibition showing the adaptation of their air brake to the front truck of a locomotive. This arrangement is clearly shown, together with the dimensions in our illustration which is presented herewith. It will be seen that there are two bars extending across the truck from side to side, bolted to the top frames, with trunnions at their outer extremities to which the brakes are hung. On the lower bar of the frame there are pivoted two floating levers, to the central portion of which the brake shoes of one pair of wheels are attached. As the brake piston moves outward these brake shoes are thrust up against the wheel while the compression connection on the outside leads back and forces the brake beam of the other two wheels and with it its brake shoes directly against the wheels. The construction is exceedingly simple, and will be readily understood from an examination of the engravings. They also showed an air brake inspection machine, which is also illustrated herewith. The figure represents a 10-in. passenger car cylinder with the machine attached ready to compress the release spring and bring the back head into position to be bolted to the cylinder. *A* is a rack-bar having an extensible portion, *B*. They are connected together with a right and left-threaded turnbuckle, *C*. Hardened steel center points are inserted in the cross-bars of *A* and *B*, making a rigid attachment to the cylinder by a slight pressure on the turnbuckle when adjusted to the cylinder as shown. *D* is a movable head having an adjustable centerpiece, *E*, for the cylinder head to rest on; this is raised or lowered to suit the size of the cylinder. A pinion gear, operating in the teeth of the rack-bar *A*, is connected to the movable head *D* by a shaft, and is operated by means of a crank or hand-wheel, *G*. As the head is moved toward the cylinder it is held in position by means of a pawl, which locks the pinion gear, and is operated by the spindle *H* and spring *F*, giving the workman the use of both hands to bolt the head to the cylinder. The machine is also capable of adjustment to the 14 in. car cylinder, and includes a packing former for each size.

Scarritt Furniture Company also exhibited photographs of the Forney car seat, and notice was generally given that they have opened an office at 32 Warren Street, where their car seats are in various designs of finish, and are now on exhibition.

The Morton Safety Heating Company exhibited a model of a car floor with an application of their heating system. Our readers will remember that this system of heating consists of a line of large pipes that are filled with a porous brick that absorbs the heat of the steam that is passed through it and stores it for future use in the heating of the cars.

RECENT EXPERIMENTS IN ARMOR.

MR. C. E. ELLIS recently read a paper on this subject before the Institution of Naval Architects, from which we make an abstract, referring more particularly to the use of the Harveyized plates.

"Speaking generally, the American trials are characterized by conditions rather more favorable to the plate than to the shot, while in France, with one or two exceptions, the reverse has been the case. In England, however, and in some of the trials made abroad, the authorities appear to have gauged most accurately the resisting power of the Harvey plate to the blow to be delivered, with the result that in many cases the shot and the plate appear to be equally matched. A good instance is to be found in the trials of Messrs. Cammell's and Messrs. Vickers' 6 in. steel plates on the *Nettle*. An examination of these trials will show that, with the highest velocity (1,960 ft. per second), a 6-in. Holtzer projectile was unable to perforate the plates, damaged as they had been by two previous rounds. According to the Gavre formula, this shot would have perforated 11 in. of wrought iron (or 18 in., according to De Marre's formula), so that we get a superiority to wrought iron of at least 183 per cent. Other instances may be found in the nickel steel 10½-in. plate of Messrs. Cammell and in the nickel-steel plate of the same thickness made by my own company, tested at Shoeburyness on November 9 and October 10, 1893, respectively. The Cammell plate was curved to molds supplied by the Admiralty, and was only penetrated to the depth of 10 in. In the Brown plate the projectile stuck in the plate, broken, and we may assume that each of the plates was a fair match for the blow delivered. The gun used was the 9.2, and, with a Holtzer shot of 380 lbs. and a velocity of 2,035 ft. per second (the highest obtainable), a striking energy was obtained of 10,900 foot tons. These conditions would give, according to the Gavre or De Marre's formula, a perforation in wrought iron of 22 in. or 22¼ in., showing for the plates in question a superiority over wrought iron of 209.5 per cent. at least. Again, the Chatillon Commentry 6.7-in. plate gives an excellent example of a trial where the conditions of attack and defense approximate one another.

"Taking the severest blow, we find that the plate was not perforated by a shot which would, according to the Gavre formula, pierce a wrought-iron plate of 11.9 in., and, according to De Marre's, a plate of 13.8 in. in thickness; in other words, showing a superiority over wrought iron of 177 per cent according to the one, and of 205 per cent. according to the other formula.

"It was at first assumed that the Harvey process was considerably better adapted to nickel-steel plates than to all steel, and this is still, no doubt, the general opinion in the United States. In the Annapolis trials of 1890 the Schneider nickel-steel plate was undoubtedly superior to the all-steel plate made by the same firm; and in a trial of 3-in. plates in May, 1891, the nickel-steel Harveyized plate was stated to be better than the all-steel plate. In the Indian Head trials of the same year the low carbon all-steel Harveyized plate of the Bethlehem Company was placed considerably below the high carbon nickel-steel Harveyized plate of the same company; but in this case the consideration of the question was complicated by the difference in the carbons, as it is probable that a nickel steel plate would not require to be so high in carbon as an all-steel plate to give the same resistance. Since this trial, however, it seems to have been assumed in the United States that all Harveyized plates should be made of nickel steel. In Great Britain, however, the high cost of nickel has caused manufacturers to turn their attention to producing Harveyized steel plates containing no nickel, and an examination of the details of the various trials shows that all have succeeded in proving the reverse of the theory accepted in the United States. There may, perhaps, be a slightly greater tendency to crack in the all-steel than in the nickel-steel plates as tested in this country; but this is more than compensated for in the superior resistance to penetration. The 6 in. Portsmouth trials all demonstrate this fact; and attention may also be called to the trial on October 26, 1893, when experiment showed that the 10½-in. Brown all-steel plate more effectually broke up the 9 in. shot than was the case in the similar trial of the nickel-steel plate under the same conditions. The expense of the addition of nickel renders this question of such importance that I regret there are no foreign trials available for providing further demonstration, if such be needed.

"Apart from the question of extra cost, there are also practical considerations which affect the point in question. Some experiments made by Captain Tresidder show that a steel plate containing an ordinary percentage of nickel and a high percentage of carbon is practically unmachinable. If, therefore, a nickel-steel plate be taken containing, say, 3 per cent. of nickel, and it be supercarburized up to, say, 1 per cent., its face will be so hard (even before the chilling process is effected) that for all practical purposes it will be impossible to drill and tap the various small holes that are nearly always necessary to be made on the face of the armor plates for ships' sides. In the case of steel armor, this difficulty (which, I believe, has already arisen in the United States in the case of nickel-steel plates) does not exist, and thus one important objection to the adoption of the Harvey process for ships' plates as required by naval architects has been overcome by its application to all-steel armor in place of nickel steel.

"I must now allude to the doubts that have been expressed as to the difficulties which will be experienced by manufacturers in adapting the process to curved and twisted plates. Both the Dutch and the Austrian governments appear to have attached great importance to this consideration. No doubt there are, and will be, difficulties caused by the warping effect of the water treatment, and time alone will show whether they are as serious as the detractors of the system allege. I think, however—and I am sure I can speak for the other armor-plate manufacturers in this country—that any difficulties thus created will be readily overcome. In the first place, if a plate is uniformly heated and uniformly chilled any alteration of its form will also be uniform. A very little experience, therefore, will teach the operator the lines on which to work, particularly if the system of chilling in use is of a suitable character. We know also that the side armor for the *Maine*, made by the Bethlehem Company, has been accepted by the United States Government; and, although I have no accurate information on the point, we may safely assume that the plates were not straight. Both Messrs. Cammell and my own company have also successfully made sample Harveyized plates to molds having both curve and twist, and probably other manufacturers have done the same.

"It may be interesting to give an account of some mechanical tests showing the quality of the soft parts of Harveyized plates which have been successful in trials. In the early stages of our experiments a 4-ft. × 4-ft. × 9-in. plate was tested at Shoeburyness, breaking up the 6-in. Holtzer in the usual way without cracking. Test pieces were taken from the back of the plate with the following results:

	First Specimen.	Second Specimen.
Breaking strain per sq. in.	31 tons.	30 tons.
Elongation per cent. in 2 in	31 "	31 "
Reduction of area per cent	57 "	61 "
Cold bends without fracture	180°	180°

The plate, it may be mentioned, was not of our special armor-plate quality. It gives, however, a sufficient indication that, apart from the face, the body of the steel does not, at least, suffer from the application of the process.

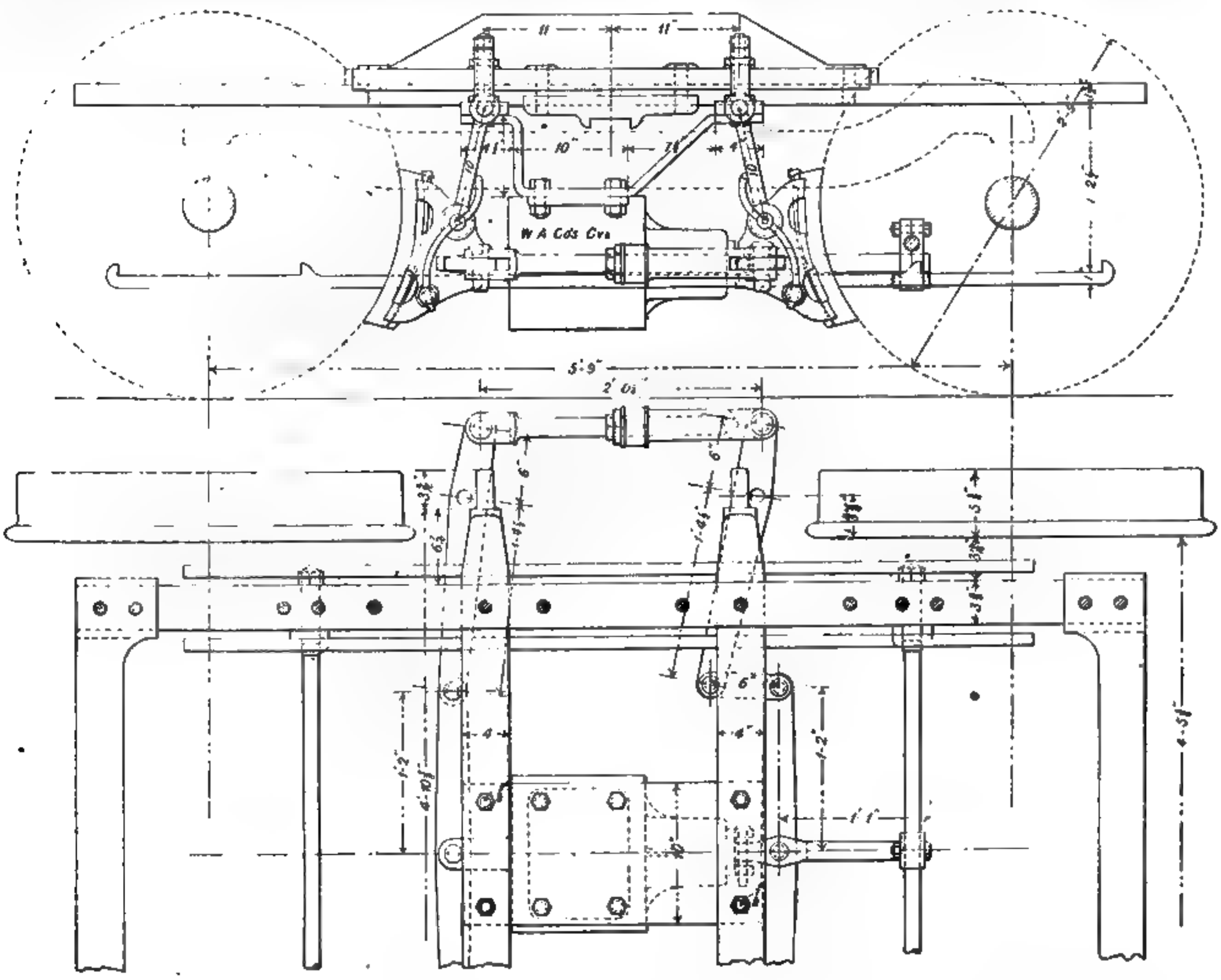
"One characteristic of this kind of plate must be specially mentioned. I refer to the extraordinary resistance given to shot by small fragments of plate only. Perhaps the most conspicuous instance of this is given by the Bethlehem 14-in. plate of February 11, 1893, where a 10-in. Holtzer projectile was fired, at a velocity of 2,059 ft. per second, at a piece of plate weighing only 4¼ tons, and was broken up with a penetration of 11 in. The total striking energy of the blow was 14,715 foot-tons, or 3,344 foot-tons per ton of plate. Another example may be found in a recent trial of a 6 in. steel plate made by my company. The fourth shot of this trial was fired nearly at the center of the plate after cracks had been made, such that the point of impact was about the middle of an equilateral triangle, with each side measuring about 2 ft. The 6-in. shot, with a velocity of 1,815 ft. per second, was completely broken up; one small crack only was made, and the fragment of plate represented by the triangle, dished to the extent of an inch, showing the tough nature of the material. If, therefore, the Harvey plate be broken up, but its fragments still adhere to the backing, it still presents a considerable resisting power. It seems, however, from the foregoing remarks, that it might be desirable to have a greater number of bolts per square foot of plate than was the case in the old form of armor.

"With the above facts before us, we are enabled to form some idea of the improvements that have recently been effected in armor plate manufacture, and of the relative value of the various kinds of armor. Without disregarding the excellent qualities of the steel and nickel plates, I think that Harveyized

armor would be a more efficient defense to the vital parts of any ship of war, whether battleship or cruiser, than any other type of plate. Opinions may differ as to the percentage of superiority it possesses, but I do not think I am overestimating its value when I place its resisting power at 50 per cent. above the steel and compound plates of 1888, which I have chosen as the basis of comparison. This advantage can be used by the naval architect in one of two ways: he can either clothe with armor a greater part of his ship, or he can obtain greater resistance, keeping the same thickness of armor. The new development is, therefore, of the greatest importance; and it will be a matter of satisfaction to this Institution that the British Admiralty have been the first naval authority in Europe to realize the value of this new form of armor, and to apply it to their most recent designs."

OBITUARY.

Robert E. Ricker.—The death of Robert E. Ricker was announced from Weeping Water, Neb., on May 18. Mr. Ricker was formerly Superintendent of the Vandalia Line, Superintendent of Motive Power of the Pennsylvania Railroad, General Superintendent and Engineer of the Central Railroad of New Jersey, and Superintendent of the Manhattan Elevated Railway, in New York.

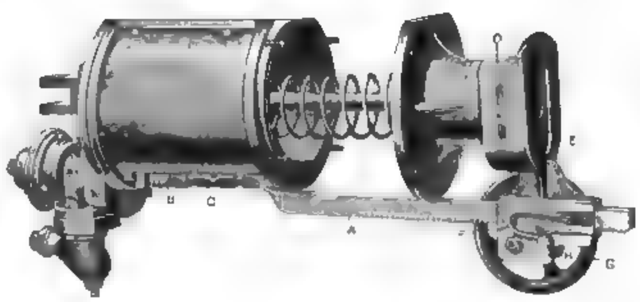


APPLICATION OF AIR BRAKE TO FRONT TRUCK OF LOCOMOTIVE.

General Notes.

Poor's Manual will hereafter be published from No. 44 Broad Street, New York.

The Bloomsburg Car Company report that, notwithstanding the dull times, they are working nearly their full force, and are just finishing a large order of freight cars for the New York, Susquehanna & Western Railroad, 50 of which are to be equipped with the beamless brake. Many features of the brake have been improved over that shown at the World's Fair. With the beamless brake, as now constructed, the stopping qualities are greatly enhanced. The company also have a large order for mining cars which are to be equipped with



AIR-BRAKE INSPECTION MACHINE.

the manganese steel wheel made by the Taylor Iron & Steel Company, of High Bridge, N. J. The capacity of the works is now rated at six freight cars a day.

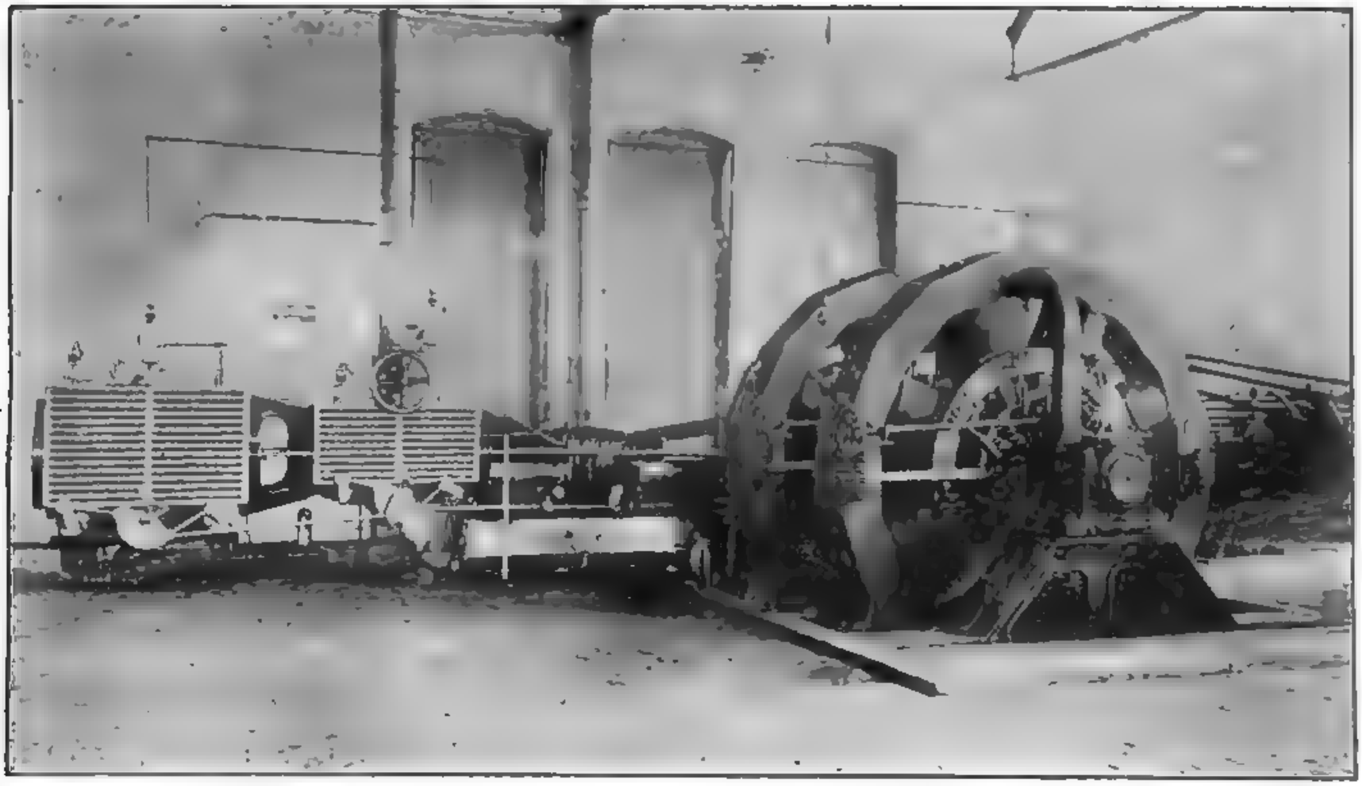
Manufactures.

DIRECT CONNECTION ENGINE AND DYNAMO.

There has been a constant tendency during recent years in the equipment of electric power and lighting plants toward the direct coupling of the engine to the dynamo shaft. The two methods in use are to use a slow-running dynamo or a

high-speed engine, both of which have given more economical results than those obtained by the intervention of belting.

vacuum of 25.75 in., the engine making the same number of revolutions, the indicated H.P. shows it 327.75 with a water consumption per indicated H P. of 15 59 lbs.



DIRECT CONNECTION ENGINE AND DYNAMO, MADE BY RUSSELL & CO., MASSILLON, O.

We illustrate in this connection a new plant which was recently installed in the station of the Edison Electric Light Company, of Grand Rapids, Mich., by Russell & Co., of Massillon, O. The installation, as will be seen from the engraving, is direct coupled dynamos and engines, and presents some features of interest which deserve especial attention. The outfit consists of one four-valve compound condensing engine 15 in. × 24 in. × 24 in., rated at from 300 to 400 H.P., and two one-killowatt generators made by the General Electric Company, of Schenectady, N. Y.

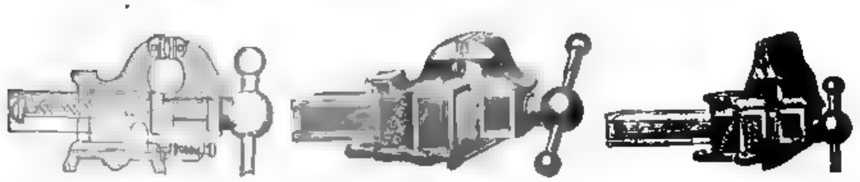
The bed of the engine and the fields of the dynamos rest upon a common iron base, the main shaft of the engine carrying, in addition to the flying wheel, the two armatures. This shaft is carried by two pillow blocks mounted in detachable iron stands so that the armatures may be removed without lifting the shaft out of place. The engine is a tandem type with the high-pressure cylinder next the cross-head, and stuffing-box between the two cylinder heads.

In a recent test conducted by Mr. Frank Simonds to determine the engine's economy in verification of the builders' guarantees, the following results were obtained:

In a six-hour trial, while running non-condensing, with an average steam pressure of 139.5 lbs., the engines making 162 revolutions per minute, the average indicated H.P. developed was 307.74 and the water consumed per indicated H.P. was 18.35 lbs. Another trial of the same length with an engine running condensing, the steam pressure being 130 lbs. with a

CAPITAL VISES AND JACK SCREWS.

The Capital Machine Tool Company, of Auburn, N. Y., are manufacturing a line of vises and jack screws, illustrations of which we give in the accompanying engravings, figs. 1, 2, 3 and 4. Fig. 1 represents a wood-work vise which opens 10 in. with one movement. Fig. 2 is the sectional 7-in. plumber's vise, taking in pipe ranging from ⅛ in. to 5 in. with one simple movement. Fig. 3 is a machinist's vise ready for use, with which the user stands in the same position as with the common screw vise. The vise is closed with one sliding motion with one hand and without turning the screw until the work is reached, and then a half turn of the handle or screw secures the work. The principal advantage claimed is that there is the great saving of time and no turn of the handles to bring the jaws to the work, simply a sliding movement, so that the wear on the screw and nut is very much less than in the old method. In this way it is naturally seen that the screw and nut are used very much less than in the old way and with a corresponding less amount of wear. The advantages claimed by their jack screws are that they are full size screws, that the collars are of steel, and screws of the same material. A diploma and medal was awarded the firm at the Chicago Fair.



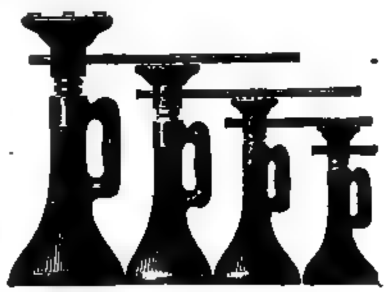


Fig. 1. Fig. 2. Fig. 3. Fig. 4.

THE CAPITAL VISES AND JACK SCREWS.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

Formerly the RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

The American Railroad Journal, founded in 1832, was consolidated with Van Nostrand's Engineering Magazine, 1887, forming the Railroad and Engineering Journal, the name of which was changed to the American Engineer and Railroad Journal, January, 1893.

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NEW YORK, AUGUST, 1894.

EDITORIAL NOTES.

THE Secretary of the Master Car-Builders' Association has issued his call for the letter ballot on the new standards that have been offered for adoption. The one which affects the largest number outside the railroad circles—in fact, the only one which does so—is that relating to the standard sizes of catalogues, circulars and specifications. It is needless to recapitulate the troubles experienced in every office in the care of catalogues, for they are very familiar to all, so the adoption of the standard may be urged on the ground of being a public benefit; and when this has been done, the fact should be extensively advertised in order that manufacturers and others may shape new catalogues in accordance with the sizes recommended.

ANOTHER proposed standard that will save a deal of misunderstanding is the one defining the terms used with reference to wheels and gauges. It might be impossible for any twelve men to agree on the most desirable point at which to locate the gauge line of car wheels; but that is no reason why all hands should not agree to adopt some specific point. Any point from the bottom of the throat to the back of the flange is better than the indefiniteness that now exists. If any one is dissatisfied with the selections made, it is no reason why he should not vote for the adoption, for in private calculations he can act as he chooses, and only when in communication with outsiders will he be obliged to speak the common tongue.

IN our column for Notes and News we chronicle two cases of record breaking that cannot fail to be of interest to those interested in naval affairs. The British Navy is now in possession of the fastest vessel in the world. The *Daring*, built by Messrs. Thornycroft & Co., has eclipsed all rivals by developing the tremendous speed of 29.8 knots for a single spurt over a measured mile. This is at the rate of nearly 34 miles an hour, or nearly up to the average express speeds between New York and Chicago a few years ago, and ahead of any speed yet developed by a boat in America. Not less remarkable and interesting is the record-breaking that has been accomplished by the *Minneapolis*, a sister ship to the *Columbia*—herself a record-breaker. Thus, England has a torpedo-boat chaser that can overhaul anything as yet afloat, and the United States has a cruiser capable of overhauling any sea-going passenger or freight steamer. The *Minneapolis* has netted her builders a fortune in the premium which she has won, and the question is being raised as to whether it would not be advisable to discard the payment of such sums as are now paid when the contract speeds are exceeded. A few years since it may be that American designers were unable to predict with precision the performance of their vessels, but surely such a state of affairs belongs to the past. Then it is doubted by many whether premiums should be paid for a speed that can never be attained while the vessel is in service, and which was attained under conditions that will never arise again.

AFTER THE BATTLE.

SOME one has said that "human experience, like the stern-lights of a ship at sea, illumines only the path which we have passed over," and it might also be added that on the great ocean of life the course in which others have sailed vanishes like the phosphorescent wake of a vessel, and is thus only a momentary guide to those who follow. Experience in the past seems to have taught mankind only to a very limited extent how to avoid mistakes, and it will probably not be a much better pilot in the future. Still, as civilization has advanced, the rocks and shoals and currents have been encountered and have been marked, and some of those who are wise learn how to avoid them.

The great Pullman strike has darkened the land, has apparently failed of its purpose, or, as the newspapers announce, has "collapsed." It has caused a lamentable loss of life, great destruction of property, and enormous expense. Its direct cost is now estimated at from five to eight millions of dollars, and besides that the business of the whole country was temporarily checked and thousands of people were subjected to incalculable inconvenience and hardship. There is nothing new in all this. It is but a repetition, in a somewhat larger scale, of what has occurred over and over again. The questions which have arisen are the same, and the methods adopted for forcing a determination of them are those with which a hundred years or more of experience has made us familiar.

I the effect upon the stricken, there seems to be a noticeable analogy between a strike and a pestilence. Probably the great proportion of people who are attacked with disease regard their affliction as an exceptional visitation, and out of the regular order of events, or as something which, like an evil spirit, has invaded the system and requires to be exorcised. The experienced physician, however, has a "clear recognition of disease as being, equally with life, a process governed by what we should now call natural laws, which can be known by observation, and which indicate the spontaneous and normal direction of recovery, by following which alone can the physician succeed." Strikes are a disease of the social organism, and as ineradicable, probably, as measles or catarrh are in the human race.

Of late years, the phrase "crushing out strikes" is not heard as often as it was ten or twenty or more years ago. In those days, when a strike occurred, the image which many people seemed to have in their minds was that of the picture of St. George and the dragon, in which the employer

was St. George and the strike was the great beast, which was being trampled under foot and about to be decapitated. Somehow or other, though, this creature seemed to be a kind of a phœnix, which, if slain either by fire or sword, rose again to trouble its slayer. The attitude of mind of the people referred to was somewhat like that of those self-righteous individuals who resolved "that the earth is the possession of the saints," and who further resolved that "we are the saints.". Human nature is unfortunately so constituted that in any contest we always think that we are St. George and the other party is the dragon. At present the parties in labor contests have improved upon ancient mythology, and in the imagery of modern science "labor" pictures its employer as an octopus; and some employers appear to regard those who work for them as a kind of human microbes which infest the body politic.

To a student and observer of "the labor question," as it is called, both of these views are obviously false. The fact is, disputes between working men and their employers are as natural a result of the clashing of opposing or divergent interests as disease is of the activity and environment of the human body. Life is largely made up of disputes and adjustments of our relative interests. In our daily intercourse with our fellow-men, we adopt all sorts of means to settle or bring such altercations to a satisfactory issue, so that we may be agreed if differences arise.

Experience has evolved several methods which mankind employ to adjust their disputes. There is, first, what may be called the *barbarous* method of fighting it out, which is as old as the world and which still survives, and of which Shakespeare said:

"——shall your swords and lances *arbitrate*
The swelling difference of your settled hate?"

Then there is the *rational* way, very generally adopted in civilized communities and in all relations of life—that of *compromise*, or, as the dictionary expresses it, "a reciprocal abatement of extreme demands and rights, resulting in an agreement." Of this method Burke said, "All government, indeed every human benefit and enjoyment, every virtue and every prudent act is founded on it." If this fails, rational people resort to the *impartial* method of *arbitration*, which is defined as "the hearing and determination of a cause between parties in controversy by a person or persons chosen by the parties." Trial by jury, now a universal method of deciding disputes in civilized countries, is an evolution of the underlying idea of arbitration, which is, that two people or parties having a dispute involving personal interests will be prejudiced thereby, and therefore incapable or disqualified to judge impartially. This is a simple recognition of a trait of human nature which experience has revealed to all of us. Consequently, under such circumstances, a third party, who has no such interests and prejudices, and whose judgment would therefore not be likely to be unbalanced, is called in, and the differences are submitted to him or them with the agreement that both disputants shall then submit to the decision of the arbitrator. The law provides that the reference of certain kinds of disputes to the arbitration of a jury shall be compulsory, and supplies means for enforcing the decisions which are then made.

In arbitration there is a recognition of the general principle, confirmed by universal human experience, that in disputes personal interests are liable to blind the eyes and pervert the sense of justice of those concerned, and therefore that the determination of the matter at issue should be made by a person whose judgment is not thus perverted.

It ought also be pointed out that *arbitration* does not mean *compromise*, as many persons seem to think. Judging from the newspaper reports, neither Mr. Pullman nor his chief lieutenant, Mr. Wickes, distinguished clearly the difference in the significance of the two words. A *compromise* is "a reciprocal abatement of extreme demands and rights," while *arbitration* is the hearing and determination of a cause between parties by a third person or persons chosen by the parties. Obviously, then, there might be arbitration either with or without compromise. If one or more arbitrators had been called in before the late strike occurred, and the question in dispute had been submitted to him or them, the decision probably would have been that Mr. Pullman was altogether right and the men were in the wrong; which might have prevented the strike, with all its lamentable consequences.

Both Mr. Pullman and his representatives said they "had nothing to arbitrate," which, in substance, was saying, "we are so sure we are right that we can't be wrong," or an assumption of infallibility, which is a prerogative claimed by the Pope alone, and which is conceded to him by only a fraction of mankind. If it had been said that "we will make no compromise, and don't choose to submit any question to arbitration," they would have been saying what, it is true, they have a perfect legal right to say; and it would have expressed what they have the same right to do; but was it the most expedient course to pursue? If the position of the Pullman Company was so absolutely right and just as it was assumed to be, what reason is there for thinking that an intelligent, impartial and righteous arbitrator would have decided otherwise?

The alternatives which were presented may be represented typographically thus:

I.

ARBITRATION.

With a fair prospect of an amicable settlement of the dispute, but with the risk that no arbitrators could be chosen who would be sufficiently disinterested and wise enough to make a decision which would be just to the Pullman Company.

II.

"NOTHING TO ARBITRATE."

With the chance of a strike, which might and did cost millions of dollars, great suffering and much loss of life.

On the doctrine of business chances, which alternative was it the wisest to accept? There are possibly mathematicians who could calculate the value of the probability that no man or men could have been found to act as arbitrators, whose wisdom and sense of justice would, under the circumstances, have been adequate to making an equitable decision. That risk may be represented by n, and the chances of a strike which were incurred by the decision that there was "nothing to arbitrate" by M, and readers can assign values to the symbols. It is true that the Pullman or any other company has a perfect legal right, under such circumstances, to take either alternative; but in the present portentous aspect of this, the most important question of modern times, what would have been the wisest course to pursue?

Employers and men, it is thought, might with advantage study the meaning of the word *opportunist*, which is now encountered so often, and the policy which it personifies. The dictionary says that in politics it means one who "believes in regulating political action in accordance with circumstances and not by dogmatic principles; in general, one who makes the best of circumstances." Is it making the best of circumstances in an irreconcilable dispute, in which we are exposed to great risks, to take the position that we will not be guided by the decisions of any one else, no matter how just or wise or righteous those decisions may be?

There is a doctrine which is now floating about very generally, that when a person is absolutely certain in his own mind that he is right, that then there is nothing to arbitrate. It is safe to say that in all disputes which cannot be settled by conciliative methods there is always something which could be arbitrated—that is, there is always, in such cases, some subject or matter of disagreement which may be referred to a competent third party for decision. Probably nine men out of ten who come into our courts of justice with their disputes are sure that they have right and justice on their side, and if asked, would say,

as Mr. Pullman did, that they have nothing to arbitrate; and yet, in such cases, the law compels arbitration by judge and jury; which method, even if it does not always result in the administration of strict justice, at least has the merit, which other kinds of arbitration have, of ending contention, and is thus better than the barbarous method of reaching a decision by fighting it out.

Probably, though, the chief obstacle in the way of the adoption of arbitration to settle labor disputes is that which was very clearly stated by the editor of the New York *Sun*, who said:

"It is natural that neither side should wish to take the chances of arbitration in a struggle in which it thinks itself the stronger. Finally, arbitration can hardly help being a curtailment of rights which one party has, or thinks he has. Why should he submit to such a curtailment?"

This objection to arbitration comes from the employed as well as from the employers, and the former often make the mistake of striking first and asking for arbitration afterward, or, as the writer in the *Sun* aptly observed, "The labor agitators never want to resort to it until the hopelessness of a strike has been demonstrated. After they have caused many acts of violence and much destruction of property, they profess to be the friends of peace and arbitration."

Both parties often go into such contests with the hope and expectation that they can, by skillful management of their cause, gain an undue advantage for their side, or, in the vernacular of the shop, can "beat" the other side.

In contrast to this spirit, some experience in the settlement of a dispute some years ago on the New York Central Railroad, when Mr. William H. Vanderbilt was still at the head of that company, may be cited. At that time there was some dissatisfaction among the engineers of the road, and they had a "grievance" which had been in a state of incubation for some time, until the men were worked up to the striking point. Mr. Buchanan, who was then, as he is now, the Superintendent of Motive Power of that line, reported to Mr. Vanderbilt that he thought the men were about to strike. "What do you think we had better do?" Mr. Vanderbilt asked. Mr. Buchanan's recommendation was that Mr. Vanderbilt should meet a committee representing the men and hear their complaints and consider their cause of discontent. Mr. Vanderbilt said, "That is a good idea," and directed that the committee should be invited to meet him in his office the next day. When they arrived he treated them with consideration, told them how important their services were to the company, and had them state the cause of their discontent, which he listened to patiently. He then pointed out wherein their demands were unreasonable, and explained why he could not grant all they asked; but made such concessions as were just, and the interview wound up by formulating a proposition for mutual agreement, to be submitted by the committee to the men they represented. It was so submitted, and was satisfactory to and accepted by the men, and there was no strike, no declaration of war, no violation of law, destruction of life or property, and none of the untold evils which so often attend strikes. This, it is said, was the first committee of this kind which Mr. Vanderbilt ever "received." There is no record that this interview detracted in any way from the honor or dignity of the high position which his wealth and office gave him, or that he lost any of the influence or authority which it was his duty to exercise over the men employed on the road. On the contrary, there is every reason to believe that such negotiations, when conducted with the intention and purpose of dealing fairly, increase the esteem in which those who take part in them mutually hold each other. Mr. Buchanan, in the case cited, suggested, and Mr. Vanderbilt adopted the rational method of settling the dispute instead of the barbarous one. Now, it is quite conceivable that, in such an interview of conciliation, the two parties might not agree, as they happily did in the instance referred to. What then? must there be a declaration of war and another sacrifice of more millions of property? The impartial method of arbitration is still open. That is, if, after a full discussion, the two parties should fail to agree, they might or should assume that one or both of them are prejudiced by their own interests, which is the reason for calling in a disinterested party.

An instance of successful conciliation and arbitration was described recently in a letter of a correspondent of the London *Times* of June 19th, in which the action of the miners and the owners of mines in Northumberland and Durham, where the long and disastrous strike occurred not long ago, is described. This action seems to be of so much importance as an example of the methods which are employed in England at present to avoid and prevent strikes, that we reprint the report of it to which reference has been made. The correspondent of the *Times* said:

While the Scottish miners, who recently allied themselves with the National Federation, are preparing for a strike, the miners of Northumberland and Durham, who form the National Union, and are outside of the Federation, are in the enjoyment of undisturbed industrial peace. Their good fortune is due to the fact that they are at present engaged along with the owners in the formation of boards of conciliation. The disastrous conflict of 1892 awakened both employers and employed to a keener sense of the value of industrial peace. This lesson of experience was promptly and zealously pressed home by, among others, the Bishop of Durham, through whose intervention the wasteful dispute was at last brought to a close. After a brief interval Dr. Westcott began to hold private and informal conferences with leading employers of labor and the more prominent representatives of the miners in Northumberland, Durham and Cleveland, with the view of commending to them the "more excellent way" of conciliation, and of ascertaining their feeling on the subject. He was so much encouraged by these conferences that he was induced to convene a representative meeting of employers and employed to discuss openly the questions which had already been privately investigated and deliberated upon. The result of this meeting was, briefly, a hearty and unanimous acceptance of the principle of conciliation. Both employers and employed declared their desire to have the days of lockouts and of strikes ended. They agreed in the opinion that, whichever side nominally won, both sides were always heavy losers by the stoppage of work—that not only was machinery depreciated and capital left unemployed on the part of the owners, while wages were sacrificed on the part of the workmen to an extent far greater than could ever be recouped by a slight advance in the rate of pay, but that trade was diverted to the foreign competitor, that markets once lost were not easily recovered, and that the industrial supremacy of England was recklessly imperilled. Both parties frankly admitted that their interests were indissolubly united, and that these mutual interests could only be fairly and fully promoted by means of a policy of peace.

No formal resolution binding those who attended the public conference to any definite course was adopted. The proceedings, however, gave most encouraging promise of the adoption of a friendly understanding; and with as little delay as possible, yet without any tendency to undue haste, both parties proceeded to endeavor to form the desired board of conciliation. When the negotiations were in progress the coal owners of Northumberland gave a signal proof of their loyalty to the great and noble object of class conciliation, so eloquently and so disinterestedly commended by Dr. Westcott. The state of trade called upon them to ask their workmen to acquiesce in a slight reduction of wages, and they convinced the leaders of the miners that a reduction was justified by the lowered market prices. Nevertheless, the workmen, by a majority of votes, declined to acquiesce in the proposed reduction. In ordinary circumstances the owners would then have proceeded to issue their notices. In the interest of the board of conciliation then being formed, they, however, wisely and magnanimously forbore. They said they would delay their demand until the board was formed, and if the state of trade then seemed to call for a reduction they would submit their claim to the new body or court representing both employers and employed. Since then the Northumberland miners have officially intimated their acceptance of the constitution of the board framed by the representatives of both bodies, and the court of conciliation is now practically, though not yet formally, established. The rules provide that the board is to consist of 15 representatives from each side, with an independent

chairman. This chairman is to be elected annually by the members, and if they fail to agree, the chairman, for the time being, of the Northumberland County Council is to have the power, after conferring with the board, to nominate a gentleman for the office. The board is to have power to determine from time to time the county rate of wages. The chairman is to preside at all the ordinary meetings, and, in default of agreement on any question by the representatives of the owners and the workmen, he is to give the deciding vote, which is to be final and binding. The board is to continue until either party gives a month's notice of withdrawal, but neither side can withdraw before December 31, 1895.

The constitution of the Durham board has not yet been published, but the negotiations are making satisfactory progress, and it may be assumed that the same lines as those adopted in Northumberland will be followed. Meanwhile the movement in prices caused by the threatened strike in Scotland has changed the aspect of affairs, and in all probability nothing will be heard for some time to come of any proposal for a reduction of wages.

Such action as this, contrasted with the scenes of violence which occurred in Chicago and elsewhere, give much color of plausibility to the assertion of Mr. Stead, recently published in the *Contemporary Review*, that:

In industrial matters our American kinsfolk are where we were forty or fifty years ago, when rattening was the first word of an outlawed unionism and murder the ultimate argument against the blackleg. What Sheffield was in the palmy days of Broadhead and Crookes, before the Royal Commission was appointed which revealed the secrets of a unionism resting upon the foundation of assassination—preached as a virtue and practiced as a necessity—so Pittsburgh is to-day, and when we say Pittsburgh we say Chicago, Denver, or any other great industrial center. Our difficulties are bad enough, but they are as moonlight is to sunlight, as water is to wine compared with the industrial feuds which rage on the other side of the Atlantic.

This statement, which accords with the reports of many recent observers in America, is borne out by a dismal catalogue of violence on both sides, neither "hesitating to shoot," and the public doing nothing but keeping the ring. The Church is powerless and arbitration voted useless.

The great mischief in America is the absence of trust, the rooted disbelief in the honesty and good faith of anybody. Rightly or wrongly, American workmen seem to be convinced —I have heard picked leaders of American labor assert it again and again—that no award, no agreement is ever respected by their employers a day longer than it suits their interests to keep it. Bad faith on the part of the employers is balanced by murder and outrage on the part of the employed, while the Church, which should be the conscience of the community, is seared as with a hot iron by a conventional indifferentism to the affairs of this world.

That the fault is not alone on one side, and that there is some good ground for Mr. Stead's assertion, is indicated by the following extract from a sermon preached in New York since the first part of this article was written:

"I have often acted as an informal arbiter in settling disputes," the preacher said, "and I want to say that in the majority of cases I have found the unreasonable oppressor to be, not the employer, but the demagogue—the lazy scoundrel who, too miserably lazy to work, but with a plausible tongue in his head, found it more to his liking to run labor unions and draw a good salary from the hard earnings of his victims. It is he who, without regard to the conditions of trade, fosters in the bosom of the laboring man discontent and hatred of his employer."

That there is much truth in this view is also conceded. But it is not true that *all* the leaders of the working men, in their combinations for the protection of what they conceive to be their rights and their interests, are "demagogues," or "scoundrels," or "lazy." To be a leader of men in the defense of their just rights and interests is an honorable and a beneficent position for a man to occupy if he does it wisely and judiciously. It is true that the leaders of the men have not always been wise or judicious; that the chief characteristic of some of them seems to be an insatiable love of notoriety, but that is not confined to such leaders alone. Men like Mr. Debs may be guilty of unspeakable acts of folly, and may for that reason go into obscurity, but nevertheless trade unions will not be eradicated. Over and over again it has been announced that such unions have been broken up, but nearly always they have been reorganized stronger than they were before.

The newspapers have been pouring the vials of their wrath on the head of Debs, and probably little more will be heard of him. He and many of his friends and admirers have by this time learned that when they array themselves against the execution of the laws of the country, that the ultimate result is not doubtful; and that if the decision must be made, most of us will shoulder our muskets and will use them, if need be, in defense of law and order, no matter who is hurt. But while he may go into obscurity, trade unions are not and cannot be eradicated. The American Railway Union may be disintegrated, but the interests which it represented will be reorganized in some other form and probably by other people, and the same disputes will come up again and continue to come up. If the officers and representatives of the new associations are men of good sense and concerned most about the true interests of the members, and employers are disposed to deal fairly with them, conciliation and arbitration on a peaceful and rational basis will be possible; but if the men are represented by pot-house blatherskites, as they so often are, and if employers do not believe in nor practice the doctrine of fair play in their dealings with their men, and renew their attempts to crush out trade unions, then the barbarous methods will again be resorted to in settling disputes, which are sure to arise in the future as they have in the past. In this, as in the administration of nearly all other human affairs, the character of the administrators is the most important element.

It therefore seems of the utmost importance to employers, as well as to the men, that the officers of trade unions should be intelligent and fair-minded men. So long as a policy of repression is practiced toward trade unions, the best of the working men will be deterred from holding office in them. A hundred years of experience has shown as clearly as anything can be shown that trade unions, in a free country, cannot be "crushed out." The idea so fondly entertained by some that they can be exterminated is the blindest of folly. We will have trade unions of some kind as inevitably as we will have political caucuses, theaters and breweries. Whether these will be good or bad, whether the action of the first will be for the public good, the amusements of the second improving or degrading, and the product of the last wholesome or poisonous depends upon the people who control and conduct those "institutions." Any one of them may be the source of intolerable evil, or be a benefit to the community. It is so with a trade union. It would appear to be the part of wisdom for employers as well as working men to do all that is possible to secure their efficient organization, so that the men could be fairly represented, and the best of them should occupy the places of authority and influence, in which they have the power of doing so much harm or so much good.

What has been accomplished in England in the direction of amicable settlement of labor disputes is described as follows in a recent history.*

"In the business expansion of 1873–74," the historians say, "the employers, for the most part, abandoned their objection to recognize the unions, and even conceded, after repeated refusals, the principle or the regulation of industry by joint boards of conciliation or impartial umpires chosen from outside the trade. From 1867–75 innumerable boards of conciliation and arbitration were established, at which representatives of the masters met representatives of the trade unions on equal terms. In fact, it must have been difficult for the workmen at this period to realize with what stubborn obstinacy the employers between 1850–70 had resisted any kind of intervention in what they had then regarded as essentially a matter of private concern. When the Amalgamated Society of Engineers

* "The History of Trade Unionism." By Sidney and Beatrice Webb. London and New York: Longmans, Green & Co.

offered, in 1851, to refer the then pending dispute to arbitration, the master engineers simply ignored the proposal. The select committees of the House of Commons in 1856 and 1860 found the workmen's witnesses strongly in favor of arbitration, but the employers skeptical as to its possibility. Nor did the establishment of Mr. Mundella's Hosiery Board, at Nottingham, in 1860, and Sir Rupert Kettle's joint committees in the Wolverhampton building trades in 1864, succeed in converting the employers elsewhere. But between 1869–75 opinion among the captains of industry, to the great satisfaction of the trade, union leaders, gradually veered round. 'Twenty-five years ago,' said Alexander Macdonald, in 1875, 'when we proposed the adoption of the principle of arbitration we were then laughed to scorn by the employing interests. But no movement has ever spread so rapidly or taken a deeper root than that which we then set on foot. Look at the glorious state of things in England and Wales. In Northumberland the men now meet with their employers around the common board. . . . In Durhamshire a Board of Arbitration and Conciliation has also been formed; and 75,000 men repose with perfect confidence on the decisions of the Board. There are 40,000 men in Yorkshire in the same position.' "

Shall we in this country adopt methods which make for peace, or are we to have a perpetual declaration of industrial war?

"SUPPLEMENTARY OBSERVATIONS" OF THE ROYAL COMMISSION ON LABOR.

A Royal Commission has recently presented a final report to the British Parliament on the general subject of labor. Appended to the report were some supplementary "Observations" on the law relating to trade unions and employers' associations, which, it is said, were drawn up by the chairman, and were signed by him and several of the Commission. These "Observations," it is thought, will have very great interest in this country at the present time, when so much is being said about compulsory arbitration. The difficulties which are in the way of enforcing any such compulsion are very fully explained, and suggestions are made with reference to legislation on the subject, which are as applicable to the condition of things existing here as they are to those prevailing on the other side of the Atlantic. The greater part of these "Observations" are therefore reprinted. In them the Commission say:

"While agreeing with the report, so far as it extends, which we have signed together with the majority of our colleagues, we desire to call attention to some proposals discussed by the Commission, but with regard to which there proved to be no such general agreement as would justify their inclusion in the body of the report. It has been stated, in paragraph 153 of the report, that at present 'Collective agreements are, as a matter of fact, frequently made between great bodies of organized workmen and employers, which bodies have no legal personality and cannot sue or be sued for damages occasioned by the breach of such agreements by sections of their members. There is collective action without legal collective responsibility. While this state of things lasts it does not appear that such collective agreements can be, as between such bodies, otherwise than morally binding upon them.' We think that this state of things might be beneficially altered by some amendments of the existing law. In the following observations it must be borne in mind that when trade unions or trade associations are spoken of associations of employers as well as of workmen are included, and that if, in any particular instance, it appears to be suggested that special privileges should be conferred, or responsibilities imposed upon one class of such associations, it will probably be found that corresponding privileges or liabilities will attach to the other.

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"We think that the extension of liberty to workmen or employers to acquire fuller legal personality than that which they at present possess is desirable in order the better to secure the observance, at least for fixed periods, of the collective agreements which are now made between them in so many cases. The associations which might avail themselves of the liberty might, in some cases, be trade unions or employers' associations, and in other cases bodies of workmen employed in a few establishments, or even a body employed in a single establishment, according to the circumstances of each industry. We do not maintain that the scheme would be applicable to the circumstances of all, or even, at present, of the larger part of the industries of this country. We find, however, from the evidence, that a considerable and very important part of British industry is conducted under collective agreements made in the most formal way between highly organized trade associations, and that the substitution of agreements between associations for agreements between individual employers and individual workmen is a growing practice, and one which is intimately connected with the mode and scale upon which modern industry is at present carried on.

"It seems to us to be clear, from the evidence of both employers and employed, that the advantages of this system greatly outweigh the disadvantages. This may not have been so evident at the date when the Trade Union Act of 1871 was passed, but we think that it has now been sufficiently proved by experience that the agreements are, on the whole, in accordance with the public interest and with the circumstances of modern industry. If this is the case, then it seems to follow that further legislation is desirable to bring the law into harmony with the present state of facts and public opinion. We think that such an extension of liberty, if conceded (and in so far as it was acted upon), would not only result in the better observance for definite periods of agreement with regard to wage rates, hours of labor, apprenticeship rules, demarcation of work, profit sharing, and joint insurance schemes and other matters, but would also afford a better basis for arbitration in industrial disputes than any which has yet been suggested. To enable trade associations to enter into collective, legally binding agreements, with the consequence that in case of breach of contract they would be liable to be sued for damages payable out of their collective funds, it would not be sufficient to repeal subsection 4 of section 4 of the Act of 1871. Even if that legislative incapacity were taken away, the trade associations would be prevented by their want of legal personality from entering into such agreements, or suing or being sued, except with regard to the management of their funds and real estate. It would be necessary that they should acquire by some process of registration a corporate character sufficient for these purposes. We are anxious to make it clear that we propose nothing of a compulsory character, but that we merely desire that trade associations should have the liberty, if they desire it, of acquiring a larger legal personality and corporate character than that which they possess at present. The further powers of incorporation would not be made a condition of the existing registration, but would be offered as powers to be obtained by registration under a new Act. The motive which would, it might be hoped, influence trade associations so to register would be the desire to acquire power to enter into agreements of a more solid and binding kind than heretofore. This might be sufficient in the case of an increasing number of the trade associations.

"With regard to the collective agreements, there should probably be some statutory condition attaching to them; for instance—(1) that every agreement should specify a period for which it was intended to hold good, and a period for notice of amendment or renewal; (2) that every agreement should be registered in central and local public offices, and should be open to inspection by the public; (3) that copies of every agreement should be kept open to inspection in factories and workshops which it affected. We think that the contracting association should be responsible for observance of the collective agreement by all its members so long as they remained its members, and that every member of an association should during membership be held to be under a contract with the association for observance of the collective agreement. The effect of this would be to give to those entering into contracts with an association the right to sue it for damages in case of breach of contract by it, or any of its members, and to give an association the right to recover damages from those of its members who infringed the collective agreement. For the more convenient enforcement of the latter right some power of deciding disputes between a society and its members similar to that conferred on friendly societies by section 22 of the Friendly Societies Act, 1875, might, perhaps, be extended to trade associations. Assuming the reform which we suggest to have taken place, we are aware that some litigation might arise before it was settled what collective agreements were or were not *ultra vires*, or 'in restraint of trade,' as the latter doctrine is now understood, or would be understood, by the courts of law. We think, however, we are justified in anticipating that judicial discussion of these matters would lead to reasonable solutions of the problems which might arise in each case, and to the gradual evolution of the best general principles.

"Apart from the question of collective agreements, it may, we think, be desirable to enable trade associations to take legal action in certain cases to secure the rights of their members, and at the same time to make them responsible and legally liable for acts done by persons when acting as their

agents. Reference has been made in paragraph 108 of the report to the injury which conduct not amounting to legal intimidation may inflict upon employers or non-unionist workmen, and it has been pointed out that such persons are not prohibited from bringing civil actions to recover damages on account of such wrongs. But at present no one can be sued except the individuals who commit such wrongs, against whom adequate damages cannot always be recovered, and there appears to be no reason why trade associations should not be liable to be sued for civil wrongs charged against their officials or other persons when acting as their agents. On the other hand, it might be equally expedient to confer upon registered trade associations power to take legal proceedings on behalf of their members—for instance, under the Employers' Liability or Truck Acts, or on other matters affecting trade relations.

"The Commission have had carefully to consider the question whether the State should attempt to do more than as proposed by Mr. Mundella's Bill—promote the formation of voluntary institutions of conciliation and arbitration. It appears from the evidence that there is in many quarters a desire, sometimes on the part of workmen, sometimes on that of employers, and in some cases felt by both, that the State should do something to replace strikes and lock-outs by a more peaceable and rational way of settling trade disputes. There does not seem to be any very clear idea as to the precise manner in which this end should be accomplished, but the general notion appears to be either that the State should establish tribunals of its own, with powers like those of ordinary law courts, or that it should invest with similar powers voluntarily formed industrial tribunals. To examine this question it is desirable, in the first place, to point out what the State cannot do according to the ordinary principles accepted in this country. It seems to be obvious that the State cannot compel either individuals or bodies of men to enter into agreements, and that the State cannot compel employers to give employment or workmen to do work upon terms which they do not respectively accept. Inasmuch as strikes and lock-outs are, in practice, the assertion of these essential liberties on the part of the employers and workmen, it is clear that the State cannot prohibit acts of this kind and compel the parties to resort to tribunals of any sort instead. It was suggested in the evidence that strikes and lock-outs should be illegal and punishable in cases where arbitration had not first been resorted to. But it seems, for the reasons just given, that it is impossible to make strikes or lock-outs illegal and punishable in any case, leaving out of consideration such exceptional cases as those of the Army or Navy or certain cases especially provided for by legislation where a sudden strike in breach of contract may involve actual danger to the public. Generally speaking, it may be laid down that the State cannot compel parties to submit to arbitration matters upon which they have a perfect right to take their own line, and it cannot compel either employers or workmen to carry out, by way of specific performance, an award as to wages or other terms of service. For these reasons the Royal Commission on Trade Unions of 1867 appears to have decided rightly (while warmly advocating the extension of voluntary institutions) that no 'system of compulsory arbitration' is practicable. The question, however, arises whether it is possible to devise any means short of compulsory arbitration by which the object so widely desired—that arbitration should replace strikes and lock-outs—might be more fully attained than it is at present. It seems that although the most formidable obstacles to resort to arbitration are probably those indicated in paragraphs 140 and 141 of the report, a further obstacle may frequently be found in the uncertainty which exists as to the observance of an award when given. If an arbitrator can only pronounce a decision which may or may not be followed according to the good will of the parties the procedure is to some extent discredited. Although, as a rule, arbitration awards may be loyally accepted, and the exceptions may be very few, yet the possibility of such an exception occurring may make employers or workmen less willing to resort to a troublesome and elaborate process like formal arbitration. It has been shown that it is impossible to compel the observance of any award in these matters. It remains to be considered whether any better guarantee or motive for such observance can be obtained to supplement and strengthen the moral force which already exists. To have arbitration in the strict sense of the word there must be two or more parties capable of entering into a legal contract to submit present or future questions to arbitration, and there must be such submission. Then, before the ordinary principle of law damages can be recovered from any party who refuses to go to arbitration, or declines to act on the award when made. As things now stand large bodies of workmen or employers cannot, as such bodies, enter into legal contracts of submission to arbitration for want of legal personality, and, for the same reason, damages cannot be recovered from them, as such bodies, for refusal to go to arbitration after agreeing to do so, or for refusal to accept the result of awards.

"If, however, the suggestions which we have made were adopted, and it were put within the power of such bodies to acquire legal personality sufficient to enable them to enter into collective agreements with the legal sanction of collective liability in damages for breach of such agreements, this difficulty would be so far solved. If, under such circumstances, a body had agreed to submit future disputes on one or more subjects to arbitration and subsequently refused to do so, and resorted to a strike or lock-out, it might be sued for damages, and the prospect of this, although it could not, indeed, prevent, would render less likely resort to such measures. If a strike or lock-out did take place, although it is true that any damages which could be recovered would probably not, except in the case of a small or partial conflict, be sufficient compensation, yet an action at law would render more visible the breach of contract, and serve to guide public opinion.

"The same observations will apply to the breach of an award made upon a submission under collective agreement. There would in both cases be the gain of a judgment publicly pronounced by a competent authority, and attended and emphasized by tangible results. For instance, an employer might insist on a reduction of wages contrary to a collective agreement or to an arbitration award founded upon a collective agreement. Then, instead of striking, the workmen might continue to work at the reduced wages, and through their association sue the employer or his association for damages to the amount of the loss. Or, on the other hand, workmen might insist on a rise of wages contrary to the collective agreement of the award. Then the employer, instead of locking-out or discharging the men, might give the increase under protest and sue their association for damages. The damages being recoverable from the collective funds of the association it would not be necessary to proceed against any individual workman. Or, again, supposing that a collective agreement were in existence between an association of employers and an association of workmen, providing that no change in rates of wages should take place without the sanction of a board of arbitration, then either side refusing to submit the question for arbitration, or to abide by the results, would be liable to be sued for damages. The judgment would be pronounced by a competent authority, would be made publicly, have tangible result, and thus greatly help to form public opinion.

"It has already been pointed out that the absence of any positive guarantee for the observance of awards may deter in many cases both employers and men from resorting in practice to arbitration, although they may in theory prefer it to strikes and lock-outs. It might be anticipated that if by the method of collective agreements a more concrete guarantee were given to arbitration it would be more frequently resorted to by those who have a *bonâ fide* preference for it over more violent modes of settling differences. It must further be observed that if trade associations were able as bodies with legal personality to refer present or future questions to arbitration they could by such agreements, under the ordinary law embodied in the Arbitration Act, 1889, either constitute or indicate their own tribunals or arbitrators and clothe them with all necessary powers of procedure and enable them to make awards which could if broken be made grounds of action for damages.

"Thus, in these cases, the problem of how to give powers of procedure to voluntarily formed boards of arbitration and a legal sanction to their awards would be solved by the operation of the ordinary law as to agreements made between parties capable of contracting. Inasmuch as such tribunals would in each case be constituted or indicated and armed with powers by the effect of the formal agreement of the parties interested, they would, it might be expected, be well regarded by them, while the fact that associations and not individuals were primarily responsible for the observance of the awards might remove some of the difficulties which have hitherto attended attempts to give a legal sanction to arbitration awards in industrial matters. These observations apply both to agreements for referring general questions and to those for referring minor questions to arbitration. Supposing, for instance, a case in which two associations of employers and workmen, capable under the supposed law of entering into collective contracts, had agreed to have (1) a wages board with provision for arbitration to settle changes in the rate of wages and other general questions, and (2) a joint committee with an independent chairman to decide minor questions arising with regard to existing agreements or customs, and had further agreed that all questions should be referred by them

and their members to these boards respectively. Then in either case the effect of the agreement would be to render liable to damages the association which, or the members of which, did not respect the arrangements, but resorted to strikes or lock-outs."

THE DISCUSSIONS AT THE CONVENTIONS.

Editor AMERICAN ENGINEER AND RAILROAD JOURNAL:

Your notes on the Master Car-Builders' and Master Mechanics' conventions are well put together and to the point. Each suggestion you make would certainly improve matters.

There are still further suggestions to offer. The Master Mechanics certainly were not in session long enough to get through the business in a satisfactory manner. On Monday there was very little done practically; even the first report was not gotten through with. Why? Too much time taken up with other matters. We intended to open up at 9.30 A.M. By the time we got back to the hall it was after 11 o'clock. About 1 o'clock we had to stop our business, owing to the thunder-storm, as we were not able to hear the speakers.

Now, right here we lost so much time that we were not able to make it up the other two days.

On Tuesday we had to stop at noon hour to take up compound experiences. Here was another point lost of one hour which could (under the circumstances) have been used to better advantage. This was evident by the number of members leaving the hall when this discussion was opened.

On Wednesday it was a rush to get through and done, as it were, but still we had to resurrect the compound in the noon hour, thus losing another hour that could have been used to better advantage.

In reviewing the matter there was really very little time for discussion. The short time we were in session on Monday was occupied with the election of Auditing Committee, electing associate members, and voting on honorary members, and quite a parley of the "gaseous." Then reading of reports on Tuesday, which were very lengthy, took up so much time that very little was or could be done in the way of discussion.

Wednesday, with a lengthy report, resolutions, elections, etc., less was done. Now, it is all very well to find fault, but can we remedy it in the three days? The only remedy I see is:

First, let us open the meeting at 8 A.M. We are all at our business before that hour, and why not when we are in convention?

Second, hold two sessions on the first day if necessary.

Third, let every member speak so that *he knows* he can be heard by all. This will get the members more interested in the discussion. I sat in a good central location in the last convention, but could hear very few of the remarks made by those who were talking.

Fourth, now that the reports are to be sent to the members before leaving their homes, cannot the reading of reports be dispensed with? Could not the committee start the ball rolling by their individual remarks instead of reading the reports? This would save much time, as some of the reports are very lengthy. The members could read, mark, learn, and inwardly digest the reports before going to the convention. The reports were all very systematically prepared, and, through the nature of them, very lengthy, and if we could dispense with the reading, considerable time can be saved which would allow further discussion.

By following the above suggestions, coupled with a determination on the part of the speakers to be heard by all the members (and not get alongside the President and speak so that *he* is the only one he cares to hear him), more interest would be taken and less of the gag rules of closing the discussion which you complain of.

ONE WHO FAVORS MORE DISCUSSION.

NEW PUBLICATIONS.

PUBLIC WORKS AND MINES, AND THE TRADITIONS AND SUPERSTITIONS OF ALL COUNTRIES. By Paul Sebillot. J. Rothschild, 13 Rue des Saints Pères, Paris. 623 pp., $5\frac{1}{4} \times 8\frac{1}{4}$ in.

The book opens with an exposition of the peculiar rites and ceremonies with which the ancients, and, for that matter, some people of modern times, presided over the constructions of roads. The author devotes himself to the various superstitions of travelers, both civilized and savage, concluding with the divinations and proverbs of all countries relatively to roads. This plan is followed in all of the monographs which compose the book. The author deals successively with highways, bridges, railways, dikes, canals, locks, aqueducts, lighthouses, mines and costumes. The monograph in regard to bridges is the longest in the book—probably because in this department, with the exception of lighthouses, materials are most abundant. This is probably due, as the author suggests, to the difficulties which meet the engineer in the construction of bridges, which is far more difficult than that of roads.

The Greeks and Romans—especially the latter—had a true worship for rivers, and their first care was to sacrifice to the divinities which presided over them in order to insure their favor, or at least their neutrality, so that the college of pontiffs at Rome occupied the position of priest and engineer; and it has only been in modern times that bridge builders have lost their sacred character.

The legends and stories which surround the building of bridges in the Middle Ages, in which the constructor made a league with the devil, and the old and oft-repeated story that the devil stipulated for the first living being that passed over the bridge, and that he was cheated by the substitution of animals for men, is met with on every hand.

Attention is especially directed to the important *rôle* which bridges played in the life of the cities of the Middle Ages, and of the many civil and religious ceremonies which were inaugurated at their opening, and the laying of their foundations. One of the most interesting chapters is that relating to railways, which has been compiled by the aid of very widely scattered documents, and which have been for the most part unedited. It is difficult for us to realize at present the great amount of superstition which surrounded the early establishment of railways, unless we are willing to consider that the peasantry of Europe regarded them in the early thirties in the same way that the Chinese do to-day. For example, on page 485 there is a prayer with which the Bishop of Orleans, M. Fayet, blessed the inauguration of the first great French railway—that from Paris to Orleans, on May 2, 1843—and it was specially recommended that all Christian followers should recite this prayer and meditate upon it when confiding themselves to the cars which carried them.

In the second part the monograph on mines and miners occupies about 200 pages. The belief that mines originated, for the most part, in something supernatural, and the singular ideas which were held in regard to them, are carefully developed. Their discovery was attributed to mysterious circumstances, and to the intervention of divinities or supernatural agencies. The timid imagination of miners peopled this dark world with strange apparitions, which almost always were of a mysterious and terrible nature. Their *rôle* is habitually that of a wicked demon provoking turmoils, kindling terrible fires, amusing themselves with terrible noise in mockery of the workmen, while the latter, in order to free themselves from the awe with which they were surrounded, had recourse to ceremonies which were for the most part purely superstitious. The costumes of miners are described in the last chapters.

The book is very fully illustrated, many of the engravings being borrowed from ancient works which treated upon the subjects handled, and the 430 illustrations of the volume form one of the most interesting features of the work. The concluding pages are occupied by a list of principal works which were consulted. It is necessary to read this varied detailed analytical table, which appears at the end of the volume, to appreciate the number of different subjects which have been consulted in the compilation of this work, which is, we believe, the first one published that takes this peculiar view of public works.

LA MACHINE LOCOMOTIVE. By Edouard Sauvage. Baudry & Co., Paris. 327 pp., $5 \times 7\frac{1}{4}$ in.

The author states, in his introduction, that the book is written in order to give locomotive engineers facility of access to a description of the locomotive engine and its method of operation. In the description of the parts and their method of operation, the author has certainly succeeded in making himself very clear; at the same time he has not attempted to cover up and slide over the difficulties which necessarily present themselves to the examination of certain portions of the engine, and he warns his reader that if any passage proves to be too difficult to grasp at the first reading, that he should not be discouraged, but study the passage carefully, and then return to it after reading other portions of the work. The book is divided into nine chapters, the first of which deals with generalities such as the origin of the power engine, the forces which it exerts, the temperature of steam, the pressure of steam, the methods of

combustion, the weight and traction which the engine can exert, the hours of labor, etc.

In Chapter II he takes up the matter of the boiler, handles it very carefully and thoroughly, and in a language that is exceedingly simple. The mechanism, frames, different types of locomotives, the tenders, methods of stopping, which include the various systems of brakes in use on the French railways and instructions for handling an engine, and the work which should be done at terminal stations, are successively dealt with, and in a manner so clear that it is difficult to understand why the author should have taken the precaution to advise his readers in his introduction that some passages would be difficult to understand, and it would be well to revert to them afterward. Necessarily, the author deals with the strictly French type of locomotive, as he is writing for men engaged in French railway service; but locomotive service is becoming cosmopolitan to such an extent that his instructions and comments regarding the methods of doing locomotive work, and the weak and strong parts of the engine, are equally applicable to American engines.

Mr. Sauvage has been for many years connected with the locomotive departments of two of the largest railway departments of France, the Northern and the Eastern line, and being in constant touch with the men on the road, and with the designing and construction of the engines, his qualifications for writing such a book are far above those of the average mechanical engineer. The book is very fully and completely illustrated, and what will undoubtedly add to its popularity is the fact that it is wonderfully free from mathematics. There is hardly a formula in the whole book, and nothing that requires any knowledge above that capable of handling the simplest arithmetical problems. Unfortunately for English readers, the book is in French; but it certainly seems that a translation would be an acceptable addition to the literature of English readers.

THE STEAM ENGINE AND OTHER HEAT ENGINES. By J. A. Ewing, Professor of Mechanism and Applied Mechanics in the University of Cambridge. Macmillan & Co., New York. 400 pp., 9 × 5¾ in.

Considering what a grand subject it is, it is surprising that there are so few good books on the steam engine. Probably there is no question which an editor of an engineering paper is called on to answer oftener than the inquiry, "Which is the best book on this subject?" and it is never asked without perplexing the editor. The book before us will not lessen, but rather increase, the difficulty of answering such inquiries.

In his preface the author says that some years ago he "undertook to prepare an article on the Steam Engine and other Heat Engines for the *Encyclopædia Britannica*, and it then seemed that the subject might be appropriately treated by following the general lines which had been found suitable in lecturing to students of engineering. The article was accordingly written on these lines, but necessarily in a very condensed form." His book, he tells us, is an expansion of that article, or, rather, is based on it, but with additions and changes which virtually make it a new work. It is very doubtful whether the "general lines which have been found suitable in lecturing to students" are often a good basis for a treatise on any subject. At any rate, probably readers will bear out the assertion that most books with lecture notes for their basis are not usually satisfactory treatises. Books, though, are like people; we must accept them as they are, with their characteristics, whatever they may be, and not what they might be.

The titles of the chapters of the book before us are The Early History of the Steam Engine; Elementary Theory of Heat Engines, Properties of Steam and Elementary Theory of the Steam Engine; Further Points in the Theory of Heat Engines; Actual Behavior of Steam in the Cylinder; the Testing of Steam Engines; Compound Expansion; Valves and Valve Gears; Governing; the Work on the Crank Shaft; the Production of Steam Boilers; Forms of the Steam Engine; Air, Gas and Oil Engines.

About half of the book is devoted to the theory of the steam engine and the other half to descriptions of its organs and their functions. In looking through its pages, one is disposed to say of it that what is "new in it is not true, and what is true is not new." The first part of the criticism, though, has little or no application, as there is not much that is new. The contents consist largely of fragmentary theories and statements of facts relating to the subjects discussed, which are collected together into chapters, and are often undigested, incomplete, and generally unsatisfactory.

The mechanical work—that is, the printing, paper and binding—are all excellent; and it has a good index, for which merits let the author and publisher be praised.

THE ENCYCLOPÆDIA OF FOUNDRY AND DICTIONARY OF FOUNDRY TERMS USED IN THE PRACTICE OF MOLDING. *Together with a Description of the Tools, Mechanical Appliances, Materials and Methods Employed to Produce Castings in all the Useful Metals and their Alloys, Including Brass, Bronze, Steel, Bell, Iron and Type Founding; with many Original Mixtures of Recognized Value in the Mechanic Arts. Also Aluminum, Plating, Gilding, Silvering, Dipping, Lacquering, Staining, Bronzing, Tinning, Galvanizing, Britannia Ware, German Silver, Nickel, Soldering, Brazing, Ores, Smelting, Refining, Assaying, etc.* By Simpson Bolland, Practical Molder and Manager of Foundries. New York: John Wiley & Sons. 535 pp., 7¼ × 5 in.

This formidable title leaves little room for saying anything else, even if a dictionary were not always the most hopeless kind of book to review; and one is always disposed to say of it, as the Scotchman did of Johnson's Dictionary, that it is "interesting reading, but hard to remember."

The book before us, as its title indicates, is more than a mere vocabulary with definitions. Many of the words and terms have dissertations on them occupying several pages. Thus, after the word "cupola" there is the definition: "A cupola is simply a foundry melting furnace," and then there is a fuller description of its construction, which occupies two pages. Many curious facts are given; thus, after the term "Damascus steel" it is said that "it is composed of layers of very pure iron and steel, worked with great care by heating and extraordinary forging, such as twisting, doubling, etc.," facts which probably few readers ever heard of before.

In looking over the interesting pages of this book the reflection is suggested, though, of how much more interesting it would be if it was well illustrated with engravings of the objects described.

THE EFFECT OF BRAKES UPON RAILWAY TRAINS. By Captain Douglas Galton. Reprinted with a Preface by the Westinghouse Air Brake Company. 171 pp., 6 × 9 in.

The Westinghouse Company have done railroad engineers a service in reprinting the three papers which were read by Captain Galton before the Institution of Mechanical Engineers in 1878 and 1879. Those papers are not accessible to most readers, and by their republication they are now placed within the reach of all who desire to get them.

The circumstances under which these experiments were made are described as follows in a preface to the volume before us: A short time previous to the experiments, in a discussion at the Institution of Mechanical Engineers, Mr. Westinghouse called attention to the fact that "in testing the action of various kinds of brake shoes he had observed a very marked difference in the friction of the shoes upon the wheels at high speeds and at low speeds. He believed that a determination of the facts was of great importance, and volunteered to design and construct the necessary automatic recording apparatus, and to carry out a system of experiments under the direction of any person who should be appointed by the President of the Institution to supervise the tests and report to it. The Institution immediately took advantage of this offer of Mr. Westinghouse, and designated Captain Douglas Galton, who, on behalf of the Institution, personally directed the experiments. The success of the project became assured when the London, Brighton & South Coast Railway placed a locomotive and brake van at the disposal of Captain Galton and Mr. Westinghouse, and offered every facility for conducting the experiments."

The results of these experiments were afterward embodied in the three papers which are now reprinted. The mechanical work of the reprint is all admirable. There is only one adverse criticism to make—the paper of the book has a most horrible odor—a characteristic of some of the coated paper which of late has come into use so much. In reading it one in*stink*tively holds the book to the leeward, and longs for a bottle of disinfectant.

ASPHALTUM IN 1893. By Clifford Richardson and E. W. Parker. Extract from the "Mineral Resources of the United States, Calendar Year 1893." Department of the Interior, Geological Survey, I. W. Powell, Director. Washington: Government Printing Office. 45 pp., 5¾ × 9 in.

Of this publication it may be said, generally, that it tells all about asphaltum, what is its amount of production, where it comes from, how it is produced, what it is used for, origin and history of the asphaltum paving industry, specifications for paving, life of such pavements, etc. The accounts of the sources of supply of asphaltum in California and Trinidad are especially interesting. Any one concerned in the subject will be amply repaid by reading this carefully prepared report.

THE NATIONAL SCHOOL OF ELECTRICITY. Prospectus. I. Allan Hornsby, Secretary, Chicago. In this announcement it is said that it is "the intention to organize a class in electricity in every city and town where the population will justify it." It is not assuring, though, to be told that "the course of study will occupy about one year, allowing for holiday seasons and *intemperate* weather," and "the tuition fee for the course will be $12.50." The names of a number of distinguished people are given as an "honorary faculty;" but what part if any they will take in the tuition is not told.

BRICK FOR STREET PAVEMENTS. *An Account of Tests Made of Bricks and Paving Blocks, with a Brief Discussion of Street Pavements and the Method of Constructing them.* New Edition, with a Paper on Country Roads. Prepared for the Engineers' Club of Cincinnati, April, 1894. By M. D. Burke, C.E. Cincinnati: Robert Clarke & Co. 108 pp., 6 × 9 in.

The origin of this pamphlet is explained by the author in his preface, in which he says that "a large part of the contents of it was contained in a report made to the village authorities of tests of material to be used in paving streets in Avondale, where the writer was employed as village engineer."

Sixteen different kinds of paving brick were tested. In making them "it was deemed advisable," the writer says, "to ascertain first the essential chemical ingredients; second, the ratio of absorption; third, the crushing strength; fourth, the transverse strength; fifth, the resistance to abrasion and impact." The results of these tests are very fully and lucidly described. Besides there are dissertations under the following headings: Statistics of Traffic and Durability of Pavements; the Probable Durability of a Brick Pavement; Municipal Methods; General Discussion of Pavements; What Shall be Specified; What has been Done; the Matrix; Where Should Brick be Used for Street Pavements; Maintenance; What is in a Name; Size of Paving Bricks and Country Roads.

Regarding the durability of brick pavement, the author concludes, from his abrasion tests, that the time required to wear an inch from the brick will be about 60 per cent. of that required to wear an inch from granite; and this, he says, "would seem to justify the belief that a brick pavement on Fourth Street, between Walnut and Race, in Cincinnati, should be in fair condition after ten years' traffic shall have passed over it."

The style of the book indicates that it was written by a person accustomed to deal with things and not merely write about them, and what he reports and discusses are the results of observations and are not "lecture notes," to which so much vapid technical literature owes its origin. The essay can be commended to all who want information about the subject—which is daily growing in interest—which it discusses.

COUNTRY ROADS—No. I. Edited and published bi-monthly by Isaac B. Potter, New York. 64 pp., 4½ × 6½ in.

Apparently, if we don't have good roads, it will not be for the want of literature on the subject. The above is a new candidate for public favor at 10 cents a copy and 50 cents a year. It is intended to give to people who need practical knowledge of road and street making, and who cannot afford to pay the prices commonly charged for scientific books, information in a convenient and attractive form at a merely nominal price.

This first number is certainly worth 10 cents, as the following sample of its contents will show:

"I say to every road-maker," the editor says, "it pays to think. There is money in it. . . . I believe that every citizen of this country who owns a wagon should paint in conspicuous letters on each end of it these words: 'He that hath brains to think, let him think.' If he will do this on the subject of country roads he will, perhaps, know what a horse knew years ago. . . . I have never," he says further, "had the heart to blame a kicking horse. It is the only way he has of stating his opinion—his one solitary method of filing an objection. When he kicks too much I always think of the other horses that don't kick enough; and I have seen it done under perfectly justifiable conditions—under circumstances of cruel provocation that would excuse manslaughter and justify an earthquake; and though the air was filled with splinters and profanity, I have had the happy satisfaction of seeing a dumb and patient brute deliver an eloquent and emphatic argument in behalf of downtrodden labor. The only beast that was ever know to talk is said to have called Mr. Balaam's attention to the bad going.

"If all the sixteen millions of farm horses in this country, all the faithful beasts that have become galled, and jaundiced, and wind-broken, and spavined, and foundered and mangy in our service, should make up their minds to balk and shy at every mud-hole, and, for every blow, to stand in their tracks and kick holes in the *firmament*, the question of better roads would be forever settled." (Copyright, 1894, by I. B. Potter.)

We agree with Mr. Potter that it pays men to think, especially if it enables them to write as he does; but whether it would pay sixteen millions of horses to think and begin "kicking holes in the firmament" is quite another question.

BOOKS RECEIVED.

ELECTRICITY ONE HUNDRED YEARS AGO AND TO-DAY. By Edwin J. Houston. New York: The W. J. Johnston Company, Limited.

THE ANIMAL AS A MACHINE AND A PRIME MOTOR, *and the Laws of Energetics.* By Professor R. H. Thurston. New York: John Wiley & Sons. 97 pp., 5 × 7½ in.

WEATHER-MAKING, ANCIENT AND MODERN. The *National Geographic Magazine.* Washington: published by the National Geographic Society. 28 pp., 6 × 9½ in.

TWENTY-FIFTH ANNUAL REPORT OF THE RAILROAD COMMISSIONERS OF THE STATE OF MASSACHUSETTS. Boston: Wright & Potter Printing Company, State Printers. 600 pp., 5¾ × 8¾ in.

ELEVENTH ANNUAL REPORT OF THE BOARD OF RAILROAD COMMISSIONERS OF THE STATE OF NEW YORK, *for the Year* 1893. Vol. I. Albany: James B. Lyon, State Printer. 720 pp., 5¾ × 8¾ in., with map.

PROCEEDINGS OF A NATIONAL CONVENTION OF RAILROAD COMMISSIONERS, *Held at the Office of the Interstate Commerce Commission,* Washington, D. C., May 8 and 9, 1894. Washington: Government Printing Office. 78 pp., 9 × 5¾ in.

ON METHODS USED AND RESULTS OBTAINED IN MAKING GERMICIDAL-EFFICIENCY TESTS OF A DISINFECTANT FOR USE IN RAILWAY SANITATION. By William T. Sedgwick. Boston: Beacon Press, Thomas Todd, Printer. 23 pp., 7 × 9½ in.

TRADE CATALOGUES.

PRICE LIST OF PROFESSOR SWEET'S PATENT MEASURING MACHINES, Manufactured by the Syracuse Twist Drill Company, Syracuse, N. Y. 12 pp., 3¼ × 5¾ in.

The title of this "booklet" is of itself sufficiently descriptive. The measuring machines have a micrometer screw arrangement, and are made in sizes to measure up to 24 in. An excellent and well-illustrated description, showing the special features of the instruments, is given, with prices, sizes, etc.

OUR SHARE IN COAST DEFENSE. Part III. Builders' Iron Foundry, Providence, R. I. 16 pp., 6 × 9 in.

The purpose of this pamphlet is to give a description of the 12-in. spring return mortar carriages made at the Builders' Iron Foundry. An excellent half-tone engraving is given of one of these carriages, which was exhibited at Chicago, with outline engravings showing side and end views, and a plan of the mortar and carriage. In the description the publishers say that they have followed quite closely the wording of the report of the Government Inspector at the works.

SKINNER PATENT CHUCKS, Manufactured by the Skinner Chuck Company, New Britain, Conn. 48 pp., 6 × 9 in.

This company manufactures and have described in their new catalogue independent, universal, combination, and universal and combination lathe chucks, drill and planer chucks, and face-plate jaws, etc. These and their different parts are illustrated by over 70 wood-engravings and descriptions. The manufacturers write that they have added several new styles of chucks to their list. A new feature of their catalogue is that a number is provided for every style and size of chuck which they regularly make, whereby they can be ordered without going into detail.

AMERICAN TUBE WORKS, Boston, Mass. Seamless Drawn Brass and Copper Tubes. W. H. Bailey, Agent, 20 Gold Street, New York. 51 pp., 4½ × 7¼ in.

There are perhaps few subjects so provocative of profanity to mechanical engineers as wire gauges. The American Tube Works have done something to lessen such infractions of the

moral code by giving, in a clear and concise form in the beginning of their catalogue, the sizes of the Stubs' and the Brown & Sharpe gauges. Elaborate tables are afterward given of the sizes and weights of the tubing made by this company, and the volume ends with some very convenient pages of cross-section paper for memoranda.

CONCERNING RED LEAD. National Lead Company, 1 Broadway, New York. Compiled by Ralph K. Wing. 29 pp., $5\frac{1}{4} \times 8$ in.

The purpose of this publication is to advocate the use of lead paints instead of other compounds. It gives first a description of what red and white lead are, and how they are manufactured. This is followed by extracts and reprints from various publications of articles on paints. These are brought together in convenient form, and give the results of the observation and experience of many persons with the use of paints under many different circumstances. The pamphlet is well worth possessing by those interested in the subject, and may be obtained by writing for it to the publishers.

THE VALUE OF TIE PLATES IN TRACK REPAIRS. An Analysis of the Dimensions, Form and Functional Purposes of Tie Plates. Read before the Buffalo Association of Railroad Superintendents, April 19, 1894. By Benjamin Reece. Published by the Q. & C. Company, of Chicago. 63 pp., $6 \times 8\frac{3}{4}$ in.

The purpose of this paper is indicated by the above title. It is an investigation, made by the author, to ascertain the value of tie plates under the rails of railroad tracks, and especially of the Servis Tie Plate, which has of late years been extensively introduced. The paper is well illustrated with a variety of engravings, showing the effects of the wear of rails on ties, and is a careful study of the subject and replete with information in which every engineer in charge of track is interested.

MODERN TURRET LATHE PRACTICE. Published by the Gisholt Machine Company, Madison, Wis. 12 pp., $7 \times 10\frac{1}{2}$ in.

This company has sent us the May and June numbers of a publication with this title, which contains half-tone engravings of the machines they make, and descriptions of the work which can be done on them. It is proposed to issue this publication monthly hereafter, which intention, no doubt, will be carried out for a short time; but it is safe to predict that the material required for each number will be exhausted before many months roll by. The machines are fairly well illustrated, and doubtless are capable of doing excellent work. The publication, as long as it is continued, will help to instruct mechanics with reference to the work which can be done on machines of this kind.

THE AERATED FUEL PROCESS OF BURNING OIL, for all Purposes for which Heat is Required in the Mechanical Arts. Gilbert & Barker Manufacturing Company, New York and Springfield, Mass. 56 pp., $6\frac{1}{4} \times 7\frac{1}{2}$ in.

Aerated fuel is crude mineral oil which is "atomized" by being fed through burners by a current of compressed air. The special apparatus which the Gilbert & Barker Company are making for this purpose is fully described in the circular before us, which is illustrated with engravings of the air compressors and the oil pumps and receiver which are used. The process is fully described, and a large number of testimonials are published, in which the opinions of those who have used the apparatus is given, and which are evidence of the extent to which this kind of fuel is now used.

A FEW PLAIN FACTS CONCERNING WATER-TUBE BOILERS. Information Pamphlet No. 3. Abendroth & Root Manufacturing Company, New York. 95 pp., $9\frac{1}{4} \times 6$ in.

This is a well-printed and elaborately illustrated pamphlet describing the well-known Root water-tube boiler. The description begins by telling us what the boiler is; next there is a statement of the claims made for it, in which its peculiarities and merits of construction are very fully described and illustrated; third, a chapter on the "Circulation in the Improved Boiler;" fourth, a "Few Special Words about Facilities for Cleaning," and last, a "General Description of the Improved Root Boiler." The publication is illustrated by over 30 wood-cuts and "half-tone" engravings, all of the very best kind. It is another illustration of the fact that the best technical literature now relating to many subjects may be found among trade catalogues.

BOSTON BELTING COMPANY, Boston, Mass. 116 pp., $3\frac{3}{4} \times 6\frac{1}{4}$ in.

In these days of industrial differentiation, one is constantly surprised at the amount of information there is to be acquired on all kinds of subjects. We have before us a new catalogue published by the Boston Belting Company, which, to use a boy's expression, is "chuck full" of information from one end to the other. There is, first, a short history of the company; then "facts relating to belting," followed by a long chapter of "suggestions for the transmission of power by rubber belting." After this are chapters describing the different kinds of belting, hose packing, valves, tubing, soling, springs, mats and matting and rubber rollers made by this company. Interspersed all through it is a great deal of valuable information which makes the catalogue a valuable acquisition for any mechanic or engineer who wants to be well up in information concerning these subjects.

THE MCSHERRY MANUFACTURING COMPANY, Manufacturers of Patent Lever, Screw and Ratchet Lifting Jacks, Dayton, O. 29 pp., $6 \times 8\frac{1}{2}$ in.

In this catalogue the manufacturers have illustrated and described nine different forms and sizes of lever jacks, which are operated by a lever and ratchet. These are intended for lifting buggies, carriages, wagons, threshing machines, portable engines, railroad cars and tracks and for wrecking purposes. Seven different kinds of screw jacks are also shown and described. These are designated as "building and bridge jacks," locomotive, coach, plug and foot-lift jacks, and are used for different purposes. Accompanying most of the illustrations of the complete jack, engravings of their different parts are shown, to facilitate the ordering of repairs. The illustrations are wood-engravings, which, though not of the best of their kind, are nevertheless very good.

BLOOMSBURG CAR COMPANY, Manufacturers of Freight, Mine and Dump Cars of Every Description, Bloomsburg, Columbia County, Pa. 55 pp., $6\frac{1}{4} \times 9\frac{1}{4}$ in.

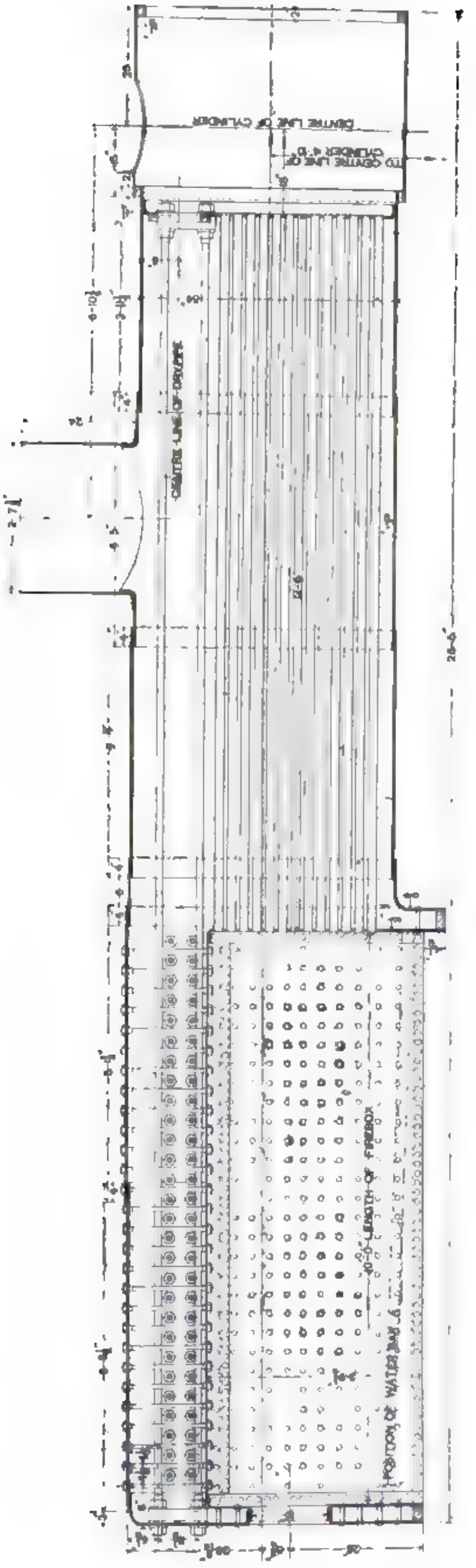
The great variety of freight cars which this company builds for different purposes are illustrated by very good wood-engravings in the new catalogue, which is before us. These include box, stock, gondola, hopper bottom, construction, flat and caboose cars for ordinary roads. Besides these, the company have manufactured a great many kinds of cars for special purposes, such as cars for narrow-gauge roads on sugar estates, dump cars of many kinds, and for a variety of purposes, mine cars of different kinds, hand and push cars, lumber trucks, etc. The company also makes wheels and axles and the beamless brake which is described and illustrated, portable beams, frogs and turn-tables for light railroads.

In their preface the publishers say they give "a general view of their works. These were first erected in 1868, and after being destroyed completely by fire in 1879, were rebuilt. To these, year by year, improvements and additions have been added, and new machinery has been introduced as fast as it was found to be necessary for the thorough equipment of the shops. The plant now covers over four acres of ground, and our shops alone cover two acres."

BELPAIRE BOILER ON THE LEHIGH VALLEY RAILROAD.

WHEN Mr. A. Mitchell was superintendent of motive power of the Lehigh Valley Railroad, he designed and put in use a Belpaire boiler with a wide fire-box, an engraving of which we give in this issue. The peculiarity to which we wish to call most particular attention in the boiler is the method of staying the back heads by running through braces, with nuts from the back head to the front tube sheet. The boiler is of such a width that it extends out over the driving-wheels, which are 4 ft. 1 in. in diameter. The rear driver stands at a distance of 4 ft. 6 in. forward of the back head of the boiler. The next one is spaced 4 ft. 5 in. ahead of this; both of these two rear drivers are therefore beneath the fire-box. As the boiler is used on consolidation engines, the other two drivers are located beneath the shell. The total driving-wheel base of the engine is 15 ft. 1 in. The pony truck stands 7 ft. $10\frac{1}{2}$ in. ahead of the front driver, so that the total wheel-base of the engine is 22 ft. $11\frac{1}{2}$ in. The total length of the boiler is 26 ft. 5 in., of which 3 ft. 4 in. is occupied by the smoke-box, 12 ft. 4 in. by the shell, and 10 ft. 9 in. by the fire-box.

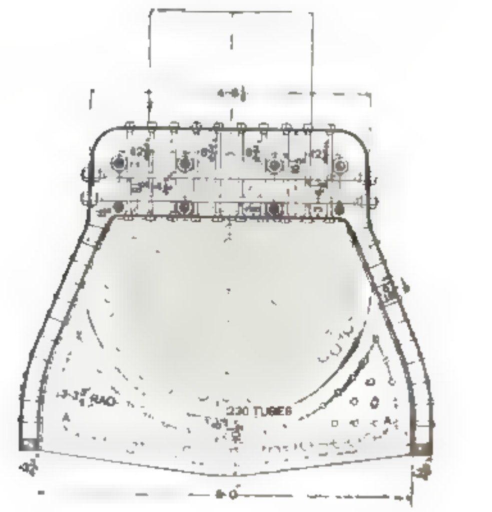
It would seem that the great length of the through stays running from the back head to the front tube sheet would cause them to vibrate and become loose in running; but inasmuch as these engines have been in service for some time and have given most excellent satisfaction, causing no trouble in this respect, we presume that the difficulty which most engineers would anticipate has not occurred. The fuel used is anthra-



BELPAIRE BOILER ON THE LEHIGH VALLEY RAILROAD FOR CONSOLIDATION ENGINE.

cite coal. The following are the specifications and the general dimensions of the boiler :

Inside diameter of smallest boiler ring	4' 4"
Material of barrel of boiler	Steel.
Thickness of plates in barrel of boiler	½"
Kind of horizontal seams	Lap.
" " circumferential seams	"
Material of tubes	Iron.
Number " "	230
Diameter of tubes outside	2"
Distance between center of tubes	2¾"
Length of tubes over tube plates	12' 6"
" " fire-box	10'
Width " "	8'
Depth " "	3' back. 5' 3" front.
Water space, side of fire-box	3½"
" " back " "	3"
" " front " "	4"
Material of outside shell of fire-box	Steel.
Thickness of plates of outside shell of fire-box	½"



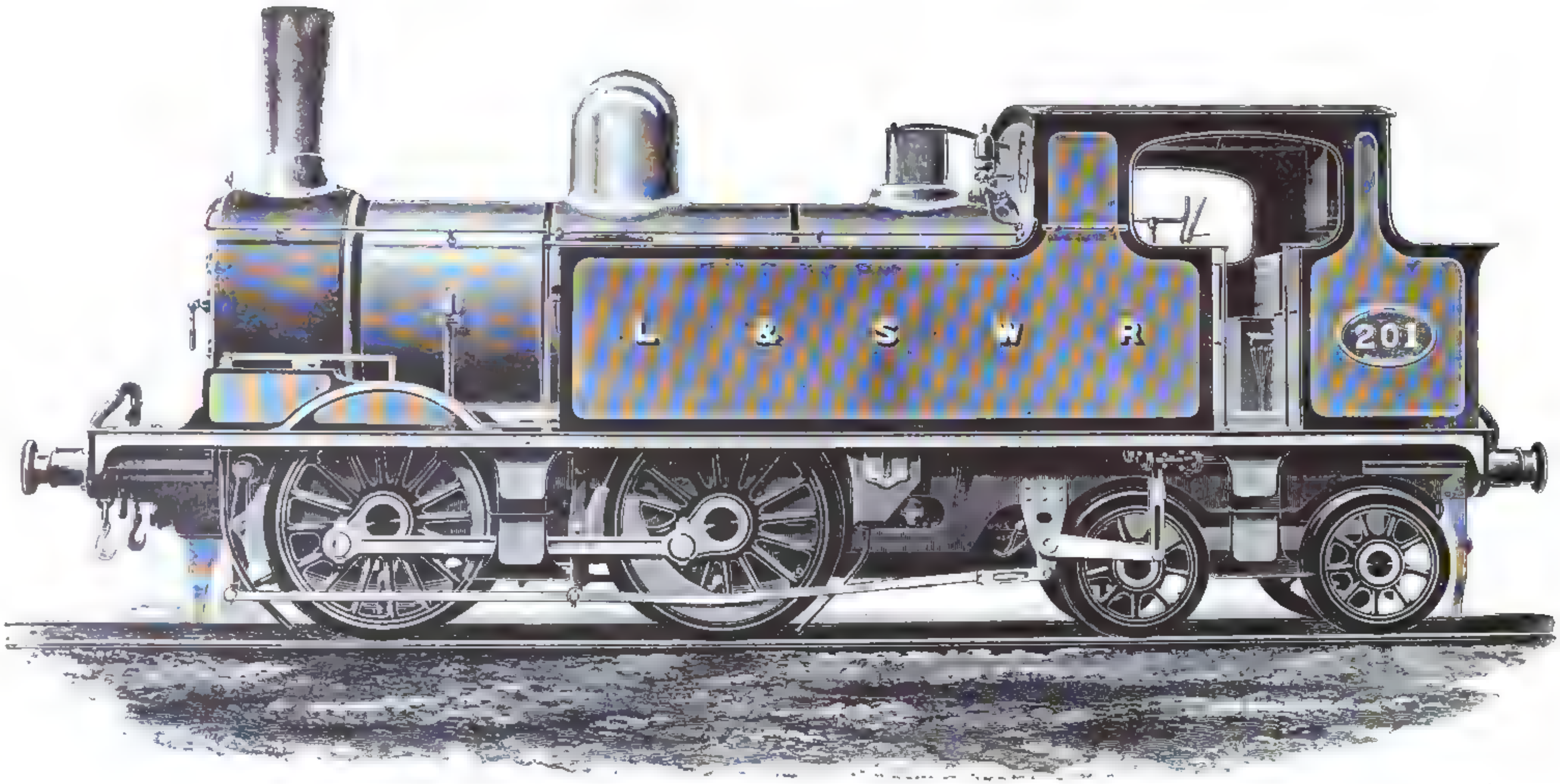
CROSS-SECTION THROUGH FIRE-BOX.

Material of inside fire-box	Steel.
Thickness of plates of inside fire-box	5/16"
" " " back end of fire-box	½"
" " crown-plate	⅜"
Material of tube-plates	Steel.
Thickness of front tube-plates	½"
" " back "	½"
Crown-bar staying	Belpaire stay-bolts.
Diameter of dome outside	2' 7½"
Height of dome to top of sheet	2'
Maximum working pressure per sq. in.	140 lbs.
Kind of grate used	Drop bars.
Width of bars (or diameter of tubes of water-grates)	2¼" diam.
" " opening between bars or tubes	⅝"
Grate area	80 sq. ft.
Heating surface in fire-box	131.7 "
" " " tubes	1,437.87 "
Total heating surface	1,568.87 "
Kind of blast nozzle	Single.
Diameter of blast nozzle	4½"
Smallest inside diameter of stack	16"
Height from top of rails to center of boiler	7' 1"

NOTES AND NEWS.

The "Cincinnati."—The cruiser *Cincinnati* is now in commission, although she is still in the hands of the mechanics. It is expected that she will be ready for a sea cruise shortly after the first of this month. The dock trials of the engines took place a few weeks ago, and were very satisfactory.

Corrosion of Water Pipes.—Considerable interest has been manifested lately, especially in the neighborhood of Boston, in the corrosion which has been brought about in gas and water pipes through the effects of electrolysis arising from the use of the rails on street railways for the return current where the trolley system is in use. It was found that the electrolytic action which was destroying the gas in water pipes occurred where the current entered or left the pipes. Various suggestions were made in order to overcome this. One was to connect ground plates with the man-holes, and so transfer the electro.



FOUR-WHEELED COUPLED TANK LOCOMOTIVE ON THE LONDON & SOUTHWESTERN RAILWAY.

lytic action to these plates. Insulation of the cables and pipes was also proposed, but nothing satisfactory has yet been devised to overcome the difficulty.

Trial of Harveyized Armor Plate.—A recent trial of Harveyized armor plate made by the Bethlehem Iron Works was made at Indian Head, the plate subjected to the test being 77 in. in thickness and made of nickel steel. It was one of the group intended for the barbettes of the battleship *Massachusetts*. A 12-in gun was used and two shots were fired. The first shot was at a velocity of 1,401 ft. per second, with a penetration of 6 in. or 7 in. The point of the projectile was welded into the plate and the base of the shell demolished. No cracks were developed and there was no disturbance. The second shot was fired at a velocity of 1,858 ft. per second. The shell is estimated to have entered the plate 10 in. or 11 in., the point remaining in the plate welded as in the first shot. The remainder of the shell was badly broken. In the second shot a fine crack was developed. It extended from the point of impact to the nearest edge. It was believed to extend through the plate, although it did not open up the target, and there was no suggestion of the huge opening which was created by the initial shot on the 18-in. plate. The results were entirely satisfactory, and will suffice to pass the materials on firing. The projectiles used were of the Carpenter type, and apparently up to the standard quality.

Four-Wheeled Coupled Tank Locomotive on the London & Southwestern Railway.—In our issue for April we published drawings and a description of a four-wheeled bogie tank locomotive that is used on the London & Southwestern Railway, which was designed by Mr. W. Adams, Locomotive Superintendent. On another page we publish a full-page engraving giving the side view of this engine, for which engraving we are indebted to the *Engineer* of London. This engraving gives a very good idea of the appearance of the engine on the road, and, coupled with our description as published in April, is sufficient to enable an engineer to reproduce the engine if he should so desire. We wish, however, to call particular attention to the broad and safe steps which are used and which characterize English locomotive practice in general, and also the arrangement of the driver brakes, in which there is no apparent compensation for variation in the wear of the shoes, in which all are brought to bearing before the breaking resistance really begins.

Testing the Dryness of Steam.—At a meeting of the Institution of Engineers and Shipbuilders in Scotland, Mr. Strohmeyer explained the method of testing the amount of moisture in steam, devised by Mr. C. J. Wilson, of University College, London. The principle, which is more particularly applicable to marine engines, consists in comparing the saltness of the steam with that of the water in the boiler. The test is carried out by means of nitrate of silver, and the reaction is so delicate that with only 1 per cent of salt in the boiler, 1 per cent of priming water can be accurately determined to the second decimal. The process is as follows: To 1 part of salt boiler water there is added 100 parts of pure condensed water, and into this there is poured a small quantity of concentrated solution of yellow chromate of potash. Then a nitrate of silver solution containing about one-tenth per cent. of this salt is slowly added. With each drop the salt water turns locally orange red, but this color disappears at first; later on, when all the salt has been acted on, the whole fluid changes color from pale yellow to orange. The quantity of nitrate solution is noted, and then the experiment is repeated on the condensed steam from the engine, undiluted with distilled water. The ratio of the quantities of nitrate of silver solution used in the two tests expresses the amount of priming in per cent.

The Fastest Ship in the World.—Under this title the *Engineer* gives some data in regard to the recent trial of H.M.S. *Daring*. This vessel is a torpedo-boat catcher, and was built by Messrs. Thornycroft & Co. In the mean runs over the Admiralty measured mile on the Maitland sands, she reached the unprecedented speed of 28.6 knots, the last of the three runs occupying only 2 minutes 3 seconds, which is equivalent to a speed of 29.3 knots. The *Daring* is the first of five torpedo-boats and destroyers in course of construction by Messrs. J. I. Thornycroft & Co., to form a part of the new destroyer flotilla which is the latest department in the Admiralty naval policy. The dimensions of the vessel are: Length, 185 ft.; beam, 19 ft.; and draft, 7 ft. These vessels have been designed for the purpose of overtaking torpedo-boats and destroying them by shell fire, and for this purpose a considerably higher speed than that of a first-class torpedo-boat is required, so that the guaranteed speed is 27 knots, to be obtained for a continuous 3 hours run at sea. They will be armed with 6 quick-firing guns of different calibers, and provision is made for fitting them as torpedo vessels if required. The largest size of the destroyers, as compared with the torpedo-boats, enables them to maintain their speed made in rough water, and to make it more difficult for the torpedo-boat to escape. The Thornycroft boats are fitted with a special system of double rudders, which give them exceptional manœuvring power, and enable them to be steered astern quite as well as ahead. This was decided on a measured mile, so that these greyhounds of the sea can double and turn as fast as the hares they pursue. The indicated H.P. is estimated from 4,800 to 4,900.

Women in Railway and Postal Service.—*Le Journal des Transports* recently had an item in regard to women in railway and postal service, and stated that women were first employed in France in post-office work. This, it seems to us, is a little doubtful, as they have been employed for many years in the postal service of the United States; but however that may be, the article goes on to state that the attempt has given such good results that some prefer women to men when the substitution is possible. In the United Kingdom women comprise 25.2 per cent. of the employés of the postal service, with the exception of the porters, who are not included in the estimate. In Switzerland women compete with men for various places in the postal and railroad service. They are very numerous in both telegraph and telephone work. In Holland eight groups only in the postal and telegraph service are open to women; 720 are engaged in railway work. The number of women working in the post-offices of Italy is very small; but in Spain they occupy almost all of the office positions in telephone work, and the Government has under consideration the proposition to increase their number in telegraph offices. In Switzerland women are more numerous than men in telegraph work, and they are admitted to all kinds of postal service with the exception of that of porter. In Norway and Denmark women have the same standing as men and the same salaries in the postal and telegraph service. In Denmark they can even occupy the position of head of department, and are admitted as stenographers in Parliament. Women are admitted to public employment on the most liberal terms in Finland. They occupy many positions in Germany, Austria, Roumania, Russia and in the English colonies. In Brazil they are admitted to government employment. In the United States of Colombia a special telegraph group has been established for them; finally, in Chili they not only occupy positions in the postal and telegraph service, but actually monopolize the position of street railway conductors.

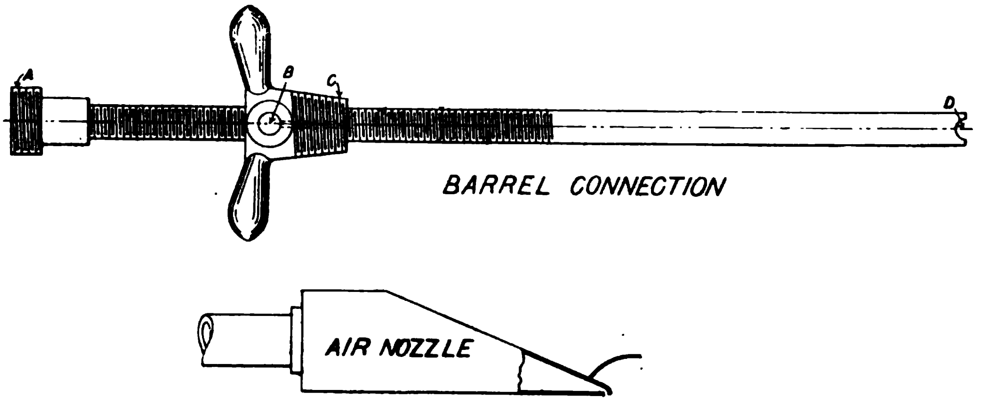
The Expense of Electric Lighting with Gas Motors.—In a paper read before the Industrial Society of Northern France, after having given a *résumé* of experiments by which he demonstrated that more light could be given by driving dynamos with gas motors than by burning the same quantity of gas in burners, M. A. Witz showed that the gas companies have been induced to establish central electric lighting stations in order to break their threatened monopoly. The initiative of this movement was taken in Germany, but there are at the present time 16 stations driven by gas engines in France. These are connected to gas works, so that these stations permit the companies to retain their patronage, while they would lose it if they persisted in offering them nothing but gas. M. Witz estimated in a general way that under these conditions a hecto-watt of light could be sold for 2 cents, while still making insufficient profits, and he arrived at these figures after a detailed and careful examination of the expenses of operation, interest and depreciation. But there would still be a considerable advantage for consumers of light if they organize groups among themselves for installing special stations that would serve isolated dwellings in the wealthy quarters as well as cafés, hotels and large stores, while a certain number of houses, by forming a syndicate, could obtain light at a low price; it is sufficient for this purpose to set up a motor and dynamo in the center of some thinly settled locality. An annual lighting of 150,000 lbs. with lamps of 16-candle power places the cost of a hecto-watt at 1.07 cents when gas costs 3 cents a cubic meter (1.3 cub. yds.), 450,000 lbs. lowers the expense to .84 cents, and it falls to .65 cents when the amount of light used amounts to 1,500,000 lbs. These figures are based upon complete details, including interest and depreciation at 15 per cent., without profit; they are very low, because the mains leading to the isolated point are usually of more length. The facilities with which a gas motor may be set up are such that it is usually preferable to use it rather than steam engines, whose boilers and stacks would not always be tolerated in the better quarters of a city. When gas is too high in price the motor can be fed with a poor gas like the Dawson or some other, in which case the numbers of hecto-watt would diminish still more. M. Witz cites numerous cases of this kind with special stations, to which he calls the attention of all those who can obtain a

right to establish them, from the gas producers. The gas motor has introduced a new element into the struggle between gas and electricity, and it furnishes a defensive arm to gas companies and to their competitors ; but it also puts into the hands of light consumers means of resisting the exactions of certain electric companies.

Coal Washing.—At a recent meeting of the Leeds Association of Engineers a visit was made to the Middleton colliery, where a coal-washing plant is in operation. This plant is the invention of a Westphalian, and by means of it seams that contain from 20 to 25 per cent of dirt can be worked so as to produce coal of a marketable quality, while under normal conditions it would be impossible to work them to a profit. The coal to be washed is lifted to a height of 85 ft. by an elevator at the rate of 75 tons per hour, and tipped into a revolving multiple drum screen, by which it is separated into five different sizes—viz., trebles, doubles, singles, peas and coking dust, the latter running through a $\frac{3}{16}$-in. mesh. The four larger sizes are carried down separate channels by means of water currents into the jigging or washing machines, in which the water is agitated by compressed air at $1\frac{1}{4}$ lbs. pressure per square inch, introduced and exhausted by means of piston valves, actuated by eccentrics. The unwashed coal rests upon wire gauze sieves, and the agitation sorts it into upper layers of coal, and lower ones of clay slate or dirt. The waste material forming the lower layers passes under slides to the bottom of the jiggers, and is drawn off to an elevator by spiral conveyers, the elevator delivering it to a hopper, whence it is carried away in trucks. The coal which forms the upper layers is floated by the water over the slides into iron culverts, and carried to masonry hoppers containing water, which prevents breakage of the coal as it falls to the bottom. When full of coal the water is drawn off, and the coal, after standing a very short time for draining, is dropped through sliding doors direct into the railway trucks. The water bringing the coal to the hoppers, which is continually overflowing and being drained off, is conveyed to large settling tanks, where the fine coal in suspension is allowed to settle, and finally sent to the coking ovens along with the small coal under $\frac{3}{16}$ in. in size from the multiple screen drum, after the latter has been passed through a Carr's disintegrator.

Use of Petroleum on Locomotives.—It is well known that the Great Eastern Railway of England has been using petroleum for a number of years on its locomotives, the engine which has been most widely illustrated and known in connection with this matter being the locomotive *Petrolia*. Recent reports show that it has been for some time hauling a train of 16 coaches on a consumption of 12 lbs. of liquid fuel and 10 lbs. of coal per mile. The regular cost of oils used is $5.04 per ton, while the coal costs $3.48. With these figures as a basis it is found that it has cost 4.25 cents for each mile run when coal and oil were used, against 5.48 cents when coal was the only fuel, thus effecting a fuel saving of about 29 per cent, or 1.23 cents per mile. There is also an additional saving in handling. It seems strange to advocates of oil fuel that the use of petroleum has not made more rapid advances on locomotive work in this country ; but recent tests on the Chicago, Burlington & Quincy Road show that when oil is at 1.7 cents a gallon, and coal at $2 a ton, the cost is about the same. If oil drops or coal rises in the relative scale of prices, then oil becomes the cheaper. Making a comparison between our American figures and those given for the English engine, we find that, taking the ordinary fuel oil as supplied to the locomotives, there would be about 500 galls. to the ton, making it cost $8.50. It will, therefore, be seen that the English oil, being nearly $3.50 per ton cheaper than the American oil, while the coal is $1.50 more expensive, the saving of oil on the English engine is very much more marked than it would be in America. If we transfer these figures to the Southern California Road, for example, which intends taking up the matter of fuel oil, where the oil costs about $1\frac{1}{4}$ cents a gallon and coal is from $6 to $8 per ton, the saving will be correspondingly great. In round numbers and for rough estimates, it may be stated that when coal costs 120 times as much per ton as the oil costs per gallon, the expense is about the same. If this ratio is increased oil will be the cheaper. If it is decreased, coal will be the cheaper.

The Use of Compressed Air on the West Shore Railroad.—It has taken some time to find it out, but now that the adaptability of compressed air to all sorts of shop uses has been demonstrated, the railroads are rapidly falling into line. At the West Shore Railroad shops, in New Durham, N. J., there is a compressing plant which supplies air for emptying the oil from the barrels into the tanks ; and we illustrate the barrel connection with which the work is done. This is a somewhat simpler arrangement than that illustrated in our July issue in connection with the report of the Master Car Builders' Association on Compressed Air Appliances and Hydraulic Machinery. It consists of a piece of extra heavy gas pipe long enough to reach through the bung-hole and rest upon the bottom of the barrel. It is threaded for some distance down from one end, and this thread carries an air connection with a taper thread upon the outside of the same pitch. This piece *C* has a boss, *B*, to which the air hose is attached, a small hole shown by dotted lines leading down to the barrel from *B* when *C* is screwed into the bung-hole. The hose leading to the tanks is screwed on the end of the pipe at *A*. Thus, when air is admitted at *B* it forces the oil through the slot *D* in the bottom of the pipe and out at *A*. At Weehawken there is another compression plant consisting of two Westinghouse air pumps with pipes leading down between the storage tracks at the depot. This air is used for car-cleaning purposes, and serves with three men to clean about eight cars a day. The nozzle used differs somewhat from those illustrated by the M. C. B. committee, in that the man in charge finds that an opening in the box directly downward gives better results than when it has a forward draft. The hood over the nozzle has also a slightly greater curvature. It is also found that a straight slot across the nozzle gives better results than one where the current of air is interrupted by rivets or other bracing for the flat sides of the nozzle.



COMPRESSED AIR ATTACHMENTS, WEST SHORE RAILROAD.

The Worst Railway in England has recently formed the subject of correspondence in our daily papers. We thought it was a generally admitted fact, quite beyond dispute, that the Southeastern & London, Chatham & Dover railways easily took the prizes for dirt, bad stations, rolling stock, unpunctuality and disgraceful accommodation generally. However, some give the Southeastern Railway the first place, while others consider "honors equally divided." The following are some pithy views on one or both of these shameful systems, expressed by correspondents :

"The Southeastern Railway is the very worst railway in the world. Its engines are asthmatic ; its lamps are trimmed by foolish virgins ; its fares are excessive ; its carriages let in snow in winter and are furnaces in summer. Its motto is unpunctuality ; its principal station is approached through the neck of a bottle. It ruins the temper, destroys the digestion and enables one to realize the horrors of Dante's Inferno."

"What wonder, then, that all women in Kent are gray-haired, and all the men bald and given to the use of strong language?"

"Of course the Southeastern Railway ; but its faults are mostly those of sheer 'cussedness.' Some time ago a main line train was 40 minutes late at Paddock Wood (I think), and in answer to more delay and playing at engines—the Southeastern Railway's favorite game—I was told by the inspector that two fish wagons had got into the middle of the train by mistake. The ticket snippers and collectors, upon whom the

management wastes thousands a year, have at Cannon Street such wretched lights that they cannot possibly spot the right half of a ticket, and the next day there are ructions! At Canterbury I once asked a porter what time a certain train was due; his answer was, 'So and so; but if you are here about 40 minutes late you will be in plenty of time!' Could not the London & Northwestern Railway spare a signal boy to put a lot of such simple matters straight? Or would the system of the Havant Line to Hayling work better, where a passenger puts up the stopping signal and buys his ticket on board? As to lights, foot-warmers, rickety engines, etc. Bah! Yours miserably, etc."—*Invention.*

Swiss Railways.—In Switzerland the use of metallic ties has advanced more rapidly perhaps in proportion to the number of ties used than in any other country, if we trust to the figures which are given by the Schweizenische Bauzeitung. The following is the proportion for five main lines—the Central, Gothard, North Eastern, Jura-Simplon and the Union. The proportions of metallic ties and of wood are given, as well as those of steel and iron rails.

	Central.	Gothard.	North-Eastern	Jura-Simplon.	Union.	Total.
Metallic ties...........	60.1	57.7	39.8	33.1	17.9	41
Wooden "	37.9	42.3	60.2	66.9	82.1	59
Steel rails	65.9	95.1	73.9	72.4	75.7	74.8
Iron "	34.1	4.9	26.1	27.6	24.3	25.2

On secondary lines fewer metallic ties are found. Nevertheless, some of them use them, and certain lines are equipped exclusively with them. Among others are several rack lines such as the narrow gauge lines of Appenzell, the one from Neufchatel to Boudry, and the electric road from Sissach to Gelterkinden, etc.

During the past few years the increase in speed and the weight of the engines has led to the use of heavier rails, so that the St. Gothard, laying rails of 101.0, 99.8 and 95.5 lbs. per yard, running over distances of 27, 26 and 10½ miles, where the Jura-Simplon Railway has 91.1 lbs. per yard rails for a distance of 51½ miles.

At the end of 1893 there were 2,222 miles of railway of all kinds in Switzerland, of which 1,640 miles were main lines operated by the Swiss companies, 39¾ miles were main lines operated by foreign companies, such as the Baden, Alsace, Lorraine, Paris, Lyons & Mediterranean, and the Mediterranean of Italy, and the Eastern State Railway; 186 miles of secondary lines of standard gauge; 184 miles of narrow-gauge lines; 98 miles of mixed railways using both adhesion and the rack; 4 miles electric lines; 49 entirely rack lines; 26 miles tramways, and 9 miles of cable lines.

Coal in Mexico.—In discussing the matter of compound locomotives it is frequently stated that there is no doubt whatever that they would show a remarkable saving and be very advantageous to use in cases where coal is expensive, as in Mexico, where the road runs from $16 to $18 a ton. In view of this fact, it has seemed strange to some of our readers that our monthly locomotive reports of coal consumption give the cost of coal on the Mexico Central Railway in the neighborhood of $4.25. In order to explain this discrepancy, we addressed a communication to Mr. Johnstone, the Superintendent of Motive Power, asking for an explanation, and adding that the only way which suggested itself to us was that the coal was bought in the United States, imported into Mexico free of duty, and that the railroad charged themselves nothing for transportation. In reply to our inquiry, we have received the following communication from Mr. Johnstone:

"The discrepancy in the value of coal between our monthly statement and the actual cost of coal in Mexico is accounted for just as you have supposed. We buy this coal under contract in large quantities in the United States; it is delivered either at El Paso or at Tampico for about $4.50 per ton American money; but this same coal, when it is hauled to points near Mexico City and consumed by the compound engines on the mountainous section of this road, actually costs the company from $16 to $18 Mexican currency. As you say, the company makes no charge for the haul, and, while our official performance sheets are made out in Mexican currency, they are reduced back to American money for the small exchange sheets, a copy of which I send you. It is rather unsatisfactory to make out these exchange sheets in American money, as the rate of exchange varies from day to day; and, while we pay our men in Mexican money the same rate per kilometer run month after month, in reducing to American money the rate changes, due to the difference in exchange. I am thinking seriously of suggesting to the management that we make out these exchange sheets in Mexican currency and in kilometers."

The Agricultural Machinery in Southern Russia.—Recent British Foreign Office reports contain some interesting and valuable information on this subject, which bears upon the American and English exports to Southern Russia. Last year at Taganrog the trade in agricultural machinery, owing to the abundant harvest, was extremely satisfactory. In some cases the demand exceeded the supply, and most of the stores sold their stocks before the end of the season. As usual, the engines and steam threshers were English, the increase of the sales being large. Binders and reapers came from America, as did half the drills. The other half were of Russian make. A large number of Russian mowers were used for cutting hay, being well suited for the purpose, with the result of diminishing the American import. The trade in plows was the same as in the previous year, the larger amount sold being of Russian manufacture. The district of Berdiansk is studded with small engineering works engaged chiefly in the manufacture of agricultural machines and implements, most of them having their own foundries. These have all sprung up within the last eight or ten years, and this branch of industry is advancing with rapid strides. At the town of Berdiansk there is the largest reaper manufactory in Europe, capable of turning out 3,000 machines annually. The bulk of the pig used is Russian, as also a great part of the bar iron. Most of the steel and other materials are imported from England, America and Germany. One well-known American house has entered into contracts to supply a considerable amount of knives and other parts of reapers for the 1894 season. The reapers made here are of a type specially adapted to the country, and not found elsewhere. Their prices, $75 to $85, bring them within the reach of the small agriculturist; the simplicity of their construction adapts them to the wants of farmers, and at the same time brings them within the power of the light Russian horses. They are durable, and get through more work than the heavier and more complicated English and American machines. That they are better suited to the wants of the country is evident by the yearly output, which within a short time has increased from a few hundreds to 20,000, while the import of American and English reapers decreases. The manufacturers are continually adding to their plant; but the best makers have never yet been able to meet the continually increasing demand. They started originally to supply the wants of the local agriculturists, but as their machines became more known, orders came from all parts of Asiatic and European Russia. They are exported to Bulgaria and Roumania, and sent nearly all round the world to the Pacific coast of Siberia. Nearly all the machine factories in the district of Berdiansk are enclosed in a circle of 70 miles radius from that town. In addition to the foregoing factories and works, nearly every village in this district has its small makers of farmers' wagons and plows. Although the work is turned out in a primitive fashion in small workshops, with the simplest of blacksmiths', joiners' and wheelwrights' tools, it is of very good quality.

Tests of Machine Guns.—The tests of the machine guns at the Washington Navy Yard recently were marred to a great extent by defective ammunition. Because of the failure of the cartridges to explode properly, the Driggs Ordnance Company was compelled to withdraw its Accles gun from the competition until it could obtain better ammunition. The smokeless powder used in the cartridges for the Accles gun is of the nitro-glycerine character and the primers used were not sufficiently powerful to explode it. The Maxim-Nordenfeldt cartridge, especially prepared for the Maxim-Nordenfeldt gun, seemingly failed to work properly, a portion of its head and base being pulled off after it had been fired, leaving the remainder of the base in to be telescoped by the next cartridge inserted into the barrel. In consequence, the results that should have been obtained from this gun were not gotten. The board which is conducting the tests consists of Commander Charles Sperry, Chairman; Professor Philip R. Alger and Ensign Albert C. Dieffenbach. The competition was inaugurated with the test of the Maxim gun, which, after it had undergone an examination, was fired 100 rounds to determine its general action, this being followed by another 100 rounds fired for rapidity, the time being 10 seconds. The gun was then clamped, and, starting with the gun empty, another 100-round trial was fired, time being 16 seconds; 200 rounds were next fired in 25$\frac{4}{10}$ seconds; 300 rounds in 40 seconds, and a full charger of 20 rounds in 6 seconds.

An army target was then placed inside the butt at a distance of 25 yards and 40 rounds fired. In this last trial a stoppage was noted, but the rounds completed to find the dispersion.

It was caused by the pulling off of the head of a case and leaving the front part of the case in the chamber. This caused the next cartridge to telescope the part left in the chamber, but the mechanism was cleaned by removing the lock. The time consumed in firing 30 rounds was $9\frac{1}{10}$ seconds. The gun was unclamped and the test repeated, the 40 rounds being fired in $15\frac{4}{10}$ seconds. Another part of the programme was clamping the gun and firing for ½ minute, the number of rounds fired in that time being 127. The gun was unfastened, and 222 rounds fired In firing 100 rounds deliberately, every fifth cartridge being a dummy, to test the effect of a miss fire upon the action, the gun worked all right, but instead of the machine firing the dummy it required to be fired by hand. Supposing that in service a lock might be disabled or extractor or firing pin broken, those parts were taken out, though in good condition, and replaced by others to test time required to do so. It took $15\frac{4}{10}$ seconds to do this. The Maxim gun was then laid aside to be further tested at Indian Head, and the board proceeded to examine the mechanism of the Gatling gun. This gun was put upon the stand on Monday. While firing the third plate it became jammed, but was quickly remedied. In firing 100 rounds more rapidly, the 81st shot jammed as before. The gun was clamped and 100 rounds fired in $10\frac{3}{10}$ seconds. Another jam occurred while firing 200 rounds, which was accomplished in $25\frac{1}{10}$ seconds. While firing 300 rounds a cartridge dropped off each plate, and two jams occurred. The time was 1 minute $12\frac{3}{10}$ seconds. Another jam took place in firing a charge of 20 rounds. The crank was shipped to the rear, and the 40 rounds fired with another jam, resulting in a flattened cartridge. Another jam occurred on firing 80 rounds, and four more in firing 100 rounds. The crank was removed to the side, and the gun unclamped, and with an addition of another man to the crew, 40 rounds were fired all right in $5\frac{6}{10}$ seconds. Eighty rounds were fired in $9\frac{7}{10}$ seconds, and 100 rounds in 15 seconds, including a stoppage of the feed for $1\frac{6}{10}$ seconds. The crank was again changed, and 40 rounds fired in $7\frac{1}{10}$ seconds; 80 rounds in $9\frac{6}{10}$ seconds. Another jam occurred while firing 100 rounds. The time consumed was over 20 seconds.

The Accles gun, controlled by the Driggs Ordnance Company, was brought from the pattern shop and 100 rounds were fired to test the action of its mechanism. The gun was manipulated by a crew from the yard. The shots went well for awhile, but it was soon noticed that defective ammunition was causing several stoppages. When 100 rounds were being fired to test the rapidity a couple of cartridge heads pulled off.

The following programme was then carried out up to noon: Firing into butt for rapidity, with the gun clamped and gun empty to begin with. This firing was done in charges of 100 rounds, 200 rounds, 300 rounds and a full charge of 25 rounds. In spite of the several delays occasioned by the bad ammunition, the best record so far was made when shooting at the targets. An army target, 6 ft. × 6 ft., at a distance of 25 yards, was fired at in charges of 40 rounds, 80 rounds and 100 rounds. The crew was firing at the target as above, with the gun unfastened, when the board took recess for dinner. An examination of some of the cartridges showed that the heads had pulled off, and in several instances holes $\frac{1}{16}$ in. wide and 1 in. long had been torn in the side of the shells.—*Army and Navy Journal.*

A NEW 999.

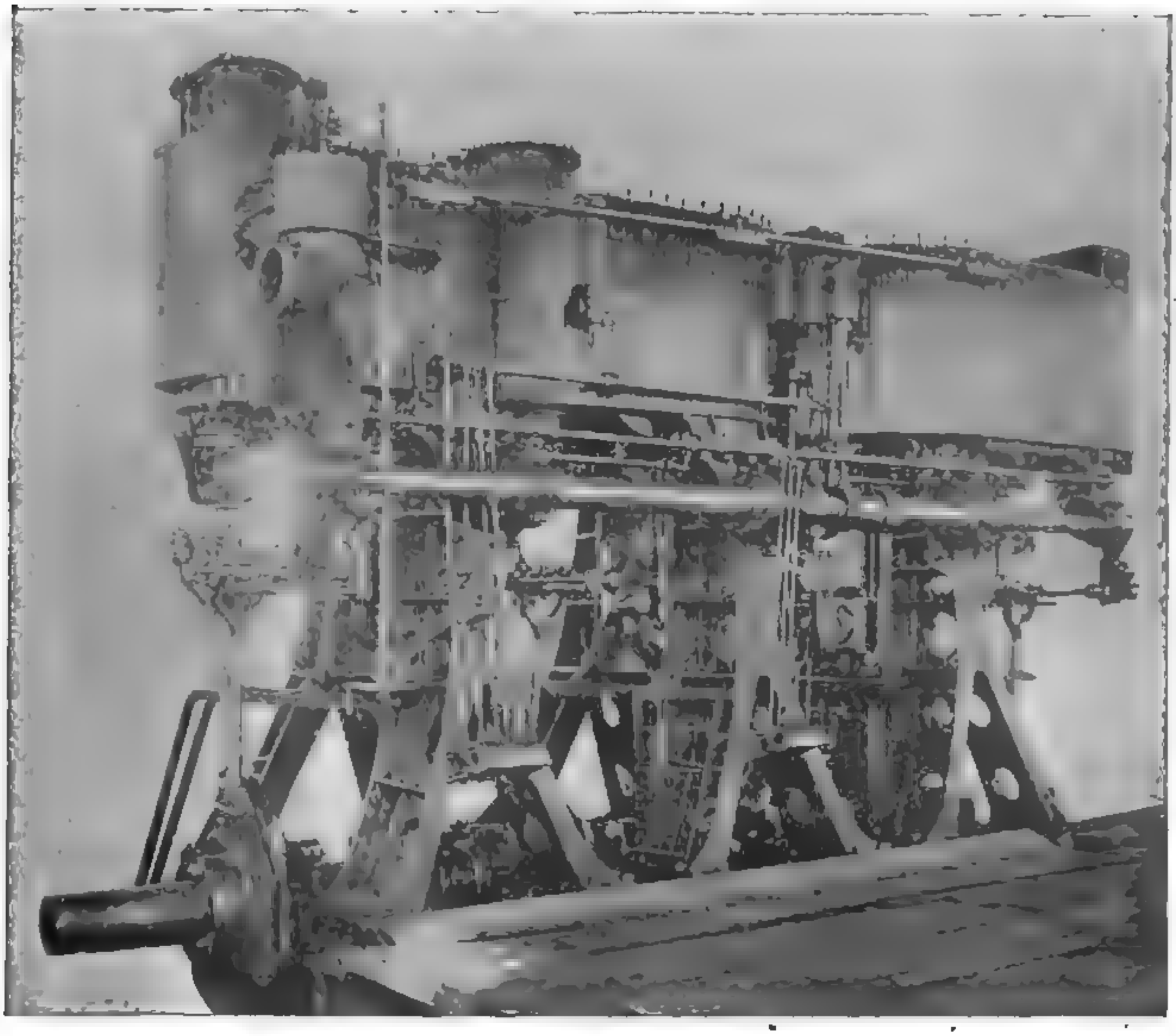
PROBABLY there was nothing at the Chicago Exhibition last summer which so thrilled the hearts of the masculine portions of the rising, and some of the risen, generations as the celebrated locomotive 999 did. That it left a permanent impression on the mind of at least one boy is shown by our illustration of his attempt to imitate this celebrated locomotive. Probably there are few of our grown-up readers who will not sympathize with him and his evident earnestness and assumption that he is engaged in serious business. He has apparently robbed the baby carriage of its wheels, the kitchen range of its boiler, the drain of a sewer pipe, and appropriated a soap box for the seat in the cab, and of these he has created another 999. It is true that the original machine will go and the new one won't; but what of that? Our young mechanical genius has the capacity which such old coveys as you and I, dear reader, have lost long ago—he "can make believe a great deal." His imaginary run with his locomotive is a much more real thing to him than any actual journey could be to us old and jaded reprobates, on whom the sun shines each year with diminished splendor, and to whom the past always has a flavor of dust and ashes, and who are unable to contemplate the future without apprehension. The run which our young hero in imagination has before him has no curves nor grades; he expects his engine will always have steam enough, and does not anticipate any collisions or derailments. May his illusion last as long as possible.

In our reflective mood we forgot to say that the young mechanical engineer who was the author of the new 999 is Henry Huss, Jr., of Mount Vernon, N. Y.

A NEW 999. BY HENRY HUSS, JR., MOUNT VERNON, N. Y.

TRIPLE-EXPANSION ENGINES OF THE UNITED STATES BATTLE-SHIP "TEXAS."

In our issue for May we published a description of the boilers and feed pumps of the United States battle-ship *Texas*, and now present a set of engravings illustrating the propelling engines which are used. These engines are rights and lefts, and are placed in water-tight compartments separated by a fore-and-aft bulkhead, this being the only fore-and-aft bulkhead in the vessel, as we have already explained in our issue for March. The water-tight compartments here run longitudinally through the length of the boiler and engine space, or a distance equivalent to the length of the armor plate. Aft and forward of these points the vessel is divided by transverse bulkheads only.



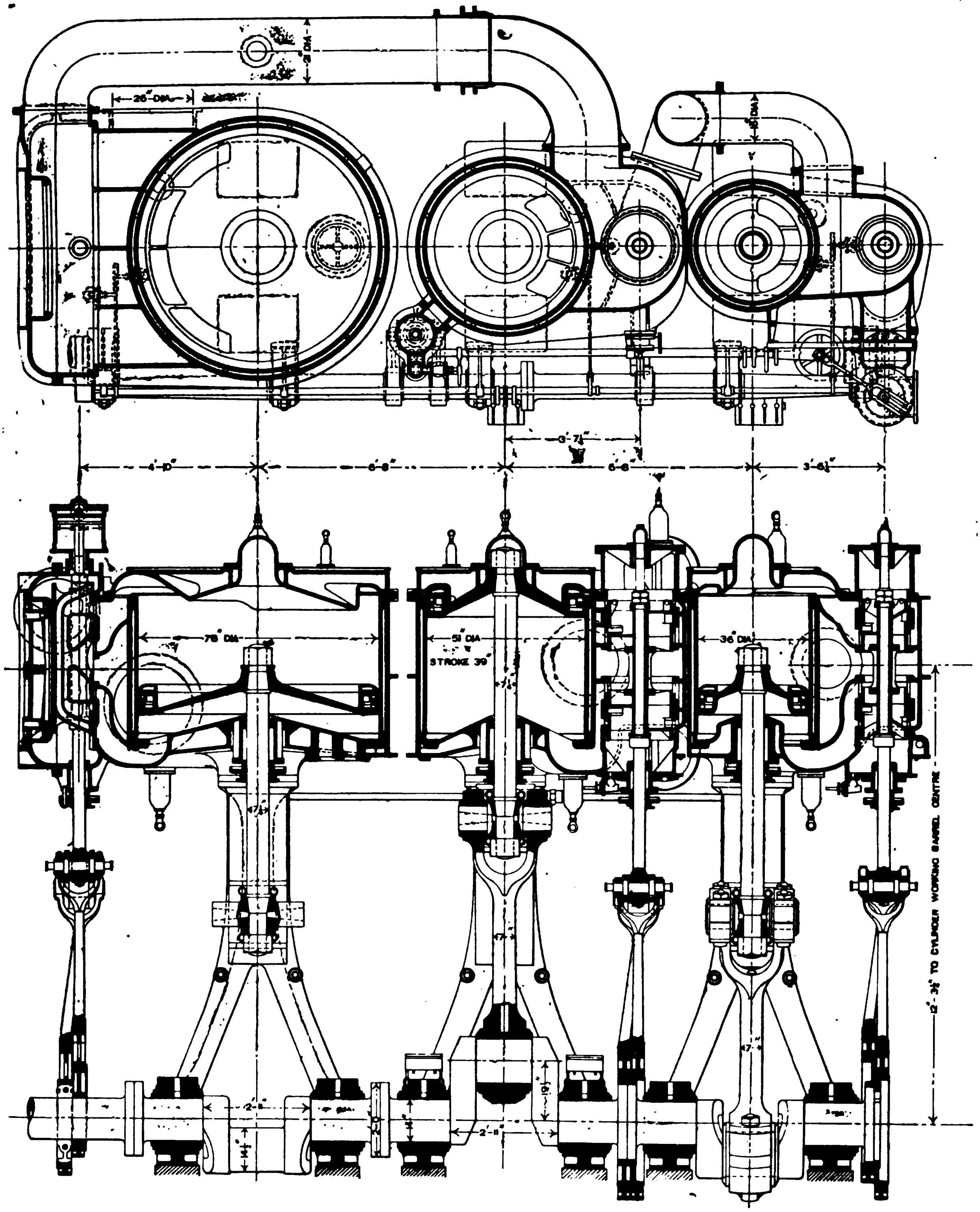
ENGINES U. S. BATTLE-SHIP "TEXAS," BUILT BY RICHMOND LOCOMOTIVE WORKS, RICHMOND, VA.

The engines are of the vertical inverted cylinder, direct-acting, triple-expansion type. The high-pressure cylinders are 36 in. in diameter, the intermediate, 51 in., and the low-pressure, 78 in., all having a common stroke of 39 in. The collective indicated H.P. of the propelling, air pump and circulating engines is placed at about 8,600, when the main engines are making 128 revolutions per minute.

A reference to our engraving, giving a longitudinal section through the engines, shows that all the cylinders are steam jacketed. They are so placed that the high-pressure cylinder of each engine is forward and the low-pressure cylinder is aft. Piston valves are used for the main valves of the high-pressure and the intermediate cylinders, while a double-ported balanced slide valve is used for the low-pressure cylinder, details of these valves being given in separate engravings. It was found on trial that the weight of the low-pressure valve was so great that the eccentrics heated, and the valve was so difficult to move that a balancing cylinder with piston, as shown in the engraving, was placed over the steam chest to carry the weight of the valve and the reciprocating parts. This is a simple cylinder 15 in. in diameter, with a piston moving therein, the upper portion of the cylinder being open to the condenser, and the lower in direct connection with the steam of the steam-chest. The Stephenson link motion, with double bar links, is used for driving all of the valves. Only one valve is used for each cylinder.

The framing of the engine consists of cast-steel inverted Y frames, trussed by forged steel stays, the appearance and shape being shown by a reproduction of the photograph and the detailed drawings of the engines. The engine bed plates are of cast steel supported on steel keelson plates built in the vessel. The crank shafts are hollow, and are made in interchangeable sections, open-hearth steel being used for all of the reciprocating and working parts, such as shafts, piston-rods and connecting-rods.

The cylinders are made from a high quality of cast iron, and have a working lining of cast steel which is shown on the engraving. The valve chests with the steam ports and passages, the bottom heads, and various brackets to which the cylinder supports and gears are attached, are cast solid with the cylinders themselves, great care being taken that the exhaust ports were smoothly cored and the walls of the passages strongly stayed with ribs. The cylinders are secured together by two steel braces 2½ in. in diameter secured to flanges cast in the proper position. The cylinder heads of the high-pres-

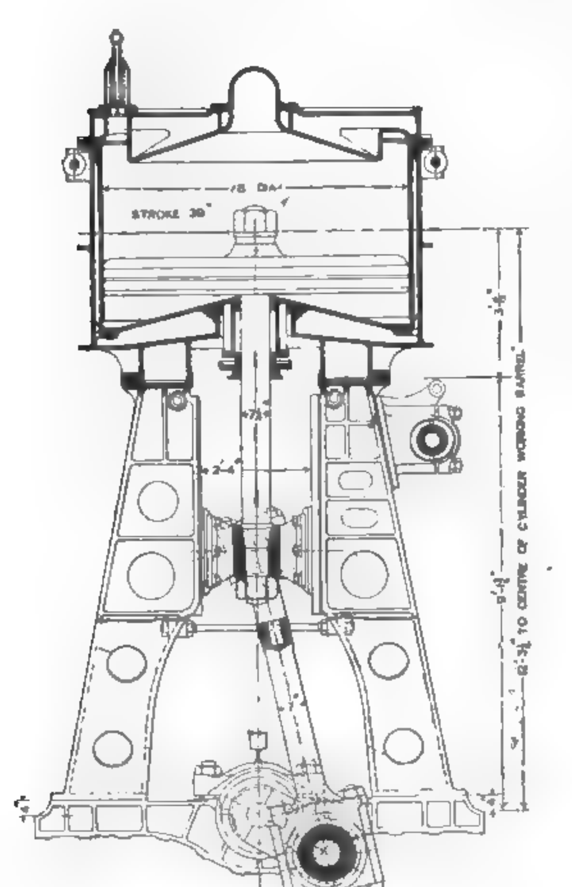


MAIN ENGINES OF THE U. S. BATTLE-SHIP "TEXAS," BUILT BY THE RICHMOND LOCOMOTIVE WORKS.

ure cylinders are cast with double walls and the shells are 1½ in. thick. They are placed and bored for the reception of the cylinder linings, the valve-chest casings being also bored to a diameter of 15 in. for the reception of the piston valves.

The bottom indicator pipe is fitted with a brass bushing which extends through the cylinder lining and casing. The intermediate and low-pressure cylinders are constructed in practically the same way, the thickness of the shell being the same for all three cylinders. The principal difference in them being that, in the bottom head of the low-pressure cylinder there is a man-hole 15 in. in diameter, which is fitted with a cast-iron cover which is also cast double and well strengthened with ribs.

The cylinder linings, to which reference has already been made, are made of cast steel carefully turned to fit the cylinder casings and guide ribs. They have inward flanges at the bottom and are secured by countersunk, slotted, cheese headed, Muntz-metal screws tapped into the cylinder shells. The joint at the upper end of each lever is made tight with a collar for expansion pipe, and a ring of round copper ⅝ in. in diameter forced into the packing space. This copper ring is held in position by a wrought-iron ring ¾ in. wide and ½ in. thick, secured to the cylinder liner by ½ in. wrought-iron square-headed tap bolts. These liners are bored to the cylinder diameters—namely, 36 in., 51 in. and 78 in.—after being placed in position, and have a uniform thickness of 1¼ in. for all the cylinders. Care was taken to bore these while the cylinders were in a vertical position, so as to prevent all springing due to the weight of the metal, so the boring was done in the working position of the cylinders. The linings are so counterbored at



ENGINE U. S. BATTLE SHIP "TEXAS," SECTION THROUGH LOW-PRESSURE CYLINDER.

the bottom that the working bores have a length of 44½ in. The cylinder heads are of the same quality of cast iron as the cylinders themselves, and are cast with double walls except at those points where they form a portion of the steam passages. The walls of these heads are well stiffened by ribs of the same thickness as the walls themselves, which is 1 in., and each head is provided with a 16-in. man-hole.

The steam jacket drains are fitted with an internal pipe leading to the lowest part of the heads, and each head is secured to its cylinder by forty 1½ in. steel studs. The man-hole covers for the cylinder-heads are of cast steel, made of a dish form, so as to clear the piston-rod nuts, and are secured by ⅞-in. steel studs. The cylinders are steam jacketed on the top, sides and bottoms, the space left about the working linings for the steam jackets being not less than 1 in. in depth at any point. The steam for the jackets is taken from the main steam pipe in each engine room on the boiler side of the engine stop valve by a 2-in. pipe. From this pipe a 1-in branch leads to the high-pressure cylinder-head jacket, which drains through a 1-in. pipe leading from the lowest part of the head, and connects with the upper part of the barrel jacket. A 1½-in. branch with a 1½-in. adjustable spring reducing valve, adapted to pressure of from 20 lbs. to 100 lbs., leads to the intermediate pressure cylinder-head jacket, and another with a similar reducing valve, ranging from 0 lbs. to 50 lbs., leads to the low-pressure cylinder-head jacket. Each branch pipe is further provided with a stop valve close to the jacket itself. Safety valves 1½ in. in diameter are placed on the intermediate and low-pressure jackets, and are of the same design as the receiver safety valves. These receiver safety valves, which are placed on the intermediate and low-pressure receivers, are 3 in. in diameter, and are loaded from 80 lbs. to 25 lbs. respectively for the intermediate and low-pressure receivers.

The valve chests of each high and intermediate cylinder is fitted with a piston valve similar in design to the intermediate valve, a detail of which is shown. There are openings at the top of the high and intermediate chests for inserting and removing the valves, and the chests are accurately bored to the same diameter as these. The low-pressure valve chest, which contains a double-ported slide valve, has an opening on the side for the purpose of removing this valve. The intermediate and low-pressure valve chests also have, in addition to the safety valve on the receivers, 3 in. adjustable spring safety valves, which are loaded to 80 lbs. and 25 lbs. respectively.

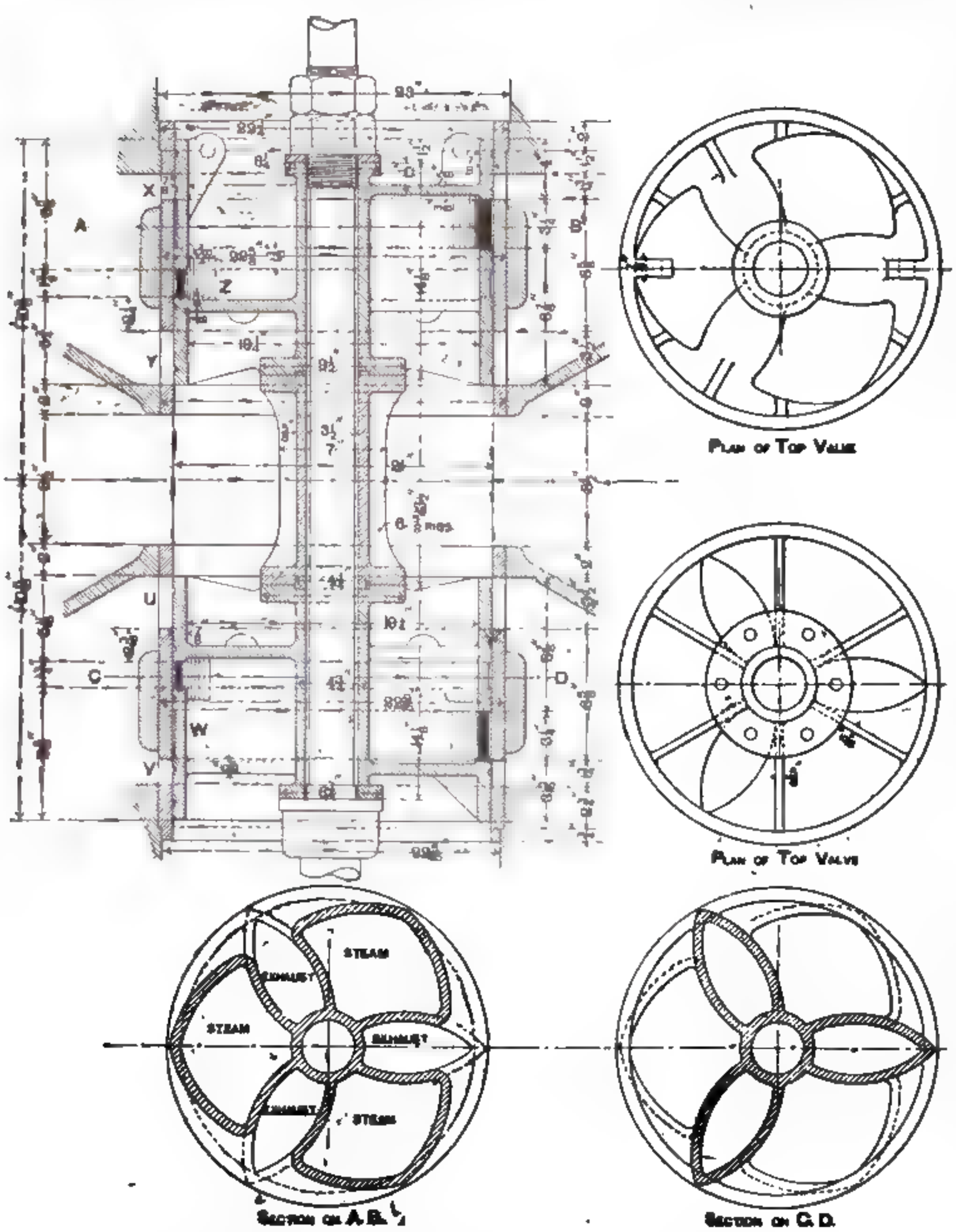
The design of the high-pressure and intermediate valves is shown by the engraving of the intermediate valve. They are made of cast iron as hard as can be properly worked and fitted accurately in the valve casings, no packing rings being used. The metal of their walls is ⅞ in. thick. Each valve consists of two hollow pistons and a distance piece which has two flanges for securing the pistons the proper distance apart. Each distance piece has six ribs ⅞ in. thick. The valves are accurately turned to fit the valve chest cases to a diameter of 15 in. and 21 in. respectively for the high-pressure and intermediate cylinders. There are five semicircular grooves on the surface of the valves at each end ⅛ in. deep for water packing. There are also two lugs on the upper portion of the valve bored with 1-in. holes for convenience in handling. The two parts of each valve are separated when in place on their vertical stem by cast-iron distance pieces which are of such length as to make the steam lead and lap as follows: High-pressure steam lead, top, ⅛ in.; bottom, $\frac{11}{16}$ in.; high-pressure steam lap, top, 2½ in.; bottom, $2\frac{5}{16}$ in. The steam lead of the intermediate cylinder is ⅛ in. at the top, and $\frac{11}{16}$ at the bottom; the steam lap of the same cylinders is 2½ in. at the top and $2\frac{5}{16}$ in. at the bottom.

The area of opening of the intermediate valves is calculated at 205 sq. in., which leaves an opening of 3¼ in. at the top and $3\frac{7}{16}$ in. for the bottom. When the engine is running at 128 revolutions per minute the flow of steam through the opening of the intermediate cylinder is 132.7 ft. per second, with an exhaust speed of 94.18 ft. An examination of the drawings and valves of this intermediate cylinder will show that the arrangement of the steam passages is of a somewhat complicated nature, but by referring the various sections to the points in which they are taken a clear understanding of the movement and distribution of the steam will be readily attained.

The drawing of the high-pressure valve, which is not reproduced here on account of its being exactly similar in design to the intermediate valve, shows that the area of the openings is calculated at 144 sq. in., which leaves an opening of 3¼ in. at the top and $3\frac{7}{16}$ in. for the bottom of the valve, the same as in the intermediate cylinder. When the engine is running at standard speed as before the flow of steam through the openings of the high-pressure valve is 92.9 ft. per second, while the exhaust is 67 ft. per second. The calculations for the low-pressure valve give an area of 374 sq. in., with an opening of 5¼ in. at the top and $5\frac{7}{16}$ in. at the bottom. With the engine at nominal speed the flow of steam is 168 ft. per second, while the rate of flow of the exhaust is 165.8 ft. per second.

The engraving, showing a vertical section through the intermediate steam-chest, with a valve in the central position, can be used to illustrate the action of the steam. Taking the cross section of the valve that is shown immediately below the vertical section of chest, and which is taken on the line *A B*. If

the valve moves down the passage *Z*, which is in communication with the top of the valve, opens into the passage *Y* at the same time that the top end of the valve opens the passage *X*, thus giving a double-ported opening into the steam passages to the cylinder. The valve being made line and line on the inside, the moment it passes the central line on its downward stroke the passage *U* is opened to the exhaust direct, and the passage *V* is also open by way of the port *W*, which is shown in dotted line. This valve is so arranged that the three steam ports have an area of 50 sq. in. each, giving a total of 150 sq. in. The three exhaust ports have an area of 18.5 sq. in. each, giving a total of 55.5 sq. in. The size and thicknesses of metal of the valves in cross section is given on the large detailed sketch of the valve of section on *C D*. The low-pressure slide valve is double ported as shown, and is made of cast iron thoroughly strengthened by ribs. There is a passage through the valves, so that the exhaust steam may be used to cushion the pistons and give a quick port opening at the commencement of the stroke. The face and back of each valve is carefully finished to true planes, and a balanced plate worked on the back of each valve. The dimensions of the valve are such that the steam lead at the top is $\frac{1}{4}$ in. and $\frac{1}{16}$ in. at the bottom. The steam lap at the top is $2\frac{1}{4}$ in. and $2\frac{1}{16}$ in. at the bottom. There is a cast-iron relief ring, 41 in. in diameter, fitted to the back of this valve to take off the pressure on the back. This relief ring is turned and faced to fit the composition bushing in the valve chest cover and back of the valve, a copper expansion ring being bolted to the relief ring and flange of the interior sleeve. The relief ring is held against the back of the valve by composition studs on a spiral round steel spring fitted in interior sleeves cast on the bonnet. These springs are made of $\frac{5}{8}$-in. round steel, the tension being regulated by wrought-iron set screws passing through composition taps screwed into the sleeves. The outside of the opening is covered with a brass plate $\frac{1}{16}$ in. thick, so as to make a smooth finish. A comparison of the longitudinal and cross sections of the valve will show that the interior and double ports are so cored out that there is a double-ported opening for the exhaust and a triple opening for steam admission. The triple opening for the steam admission is accomplished by the admission of steam at the end of the valve through the Allen port and through the central part which is cored out next the exhaust passage, and to which admission is gained from the side of the valve, as shown on the cross section. The method by which the double ported opening is obtained for the exhaust is clearly shown on the engraving. The inside lap of the slide valve is placed at $1\frac{5}{8}$ in. At the same time, there is a negative lap of $\frac{3}{8}$ in. of the Allen port, allowing steam to pass from one end of the cylinder over to the other before the exhaust opens. The valve stems are of forged steel 4 in. in diameter at the stuffing-boxes, reduced to 3 in. at the valves, the lower end of the stem being provided with a club end fitted with composition bushing and cap and bolts.



Plan of Top Valve

Plan of Top Valve

Section on A.B.

Section on C.D.

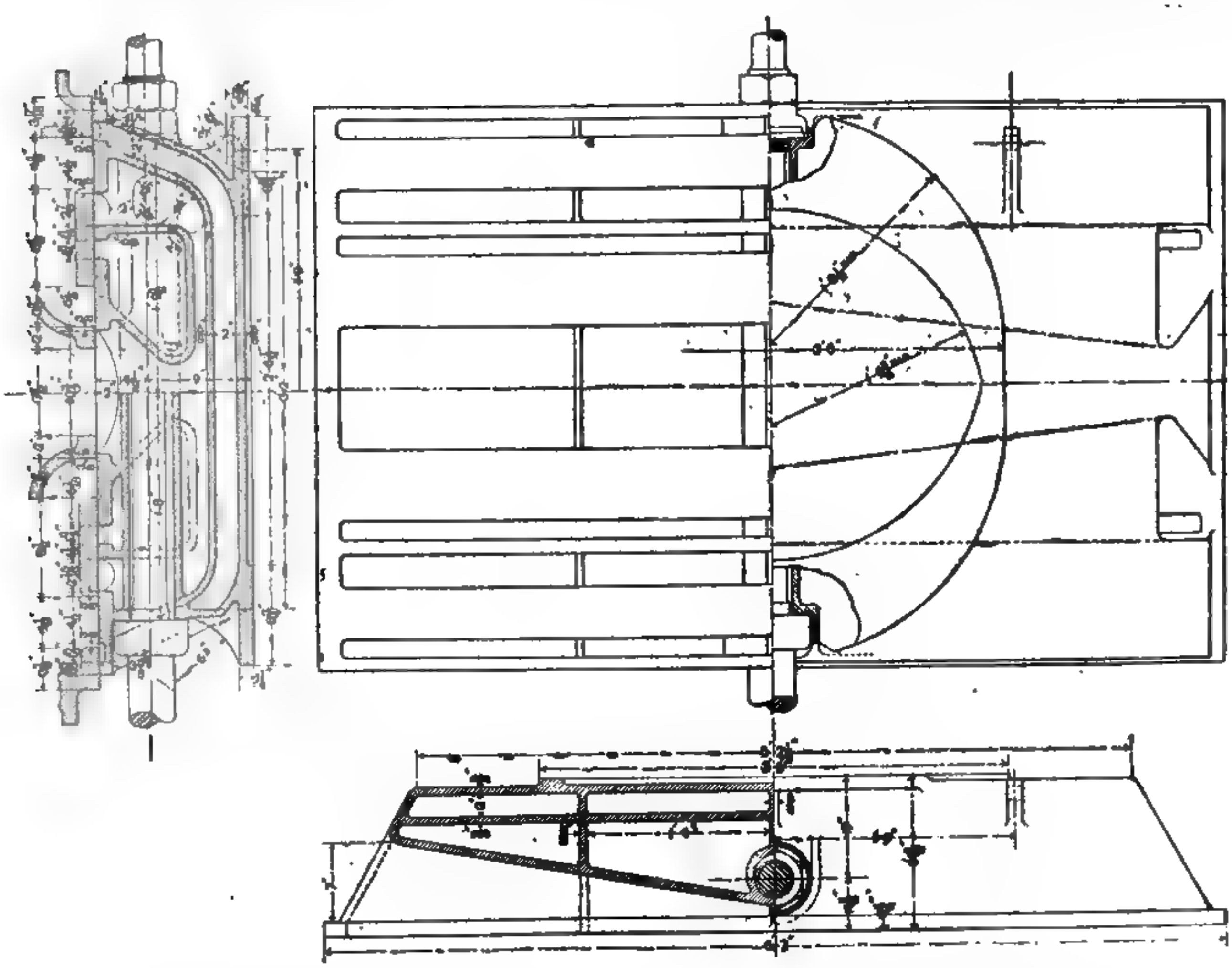
ENGINES U. S. BATTLE-SHIP "TEXAS." VALVE FOR INTERMEDIATE CYLINDER.

The indicator cards which we publish show very clearly the action of the engine and the variations in the back pressures due to the increased opening at the bottom of the cylinder. The two sets of diagrams shown are from the top ends and the bottom ends of the respective cylinders, as marked. The combination card is taken from the starboard engines and really explains itself. The top cards are taken from all the cylinders, with a uniform cut-off of $27\frac{1}{2}$ in., and give the following results: The mean effective pressure in the high-pressure cylinder was 53.04 lbs.; that in the intermediate cylinder was 33.50 lbs.; that in the low-pressure cylinder was 16.80 lbs. This was when the engine was running at 90 revolutions per minute. The resultant indicated H.P. was 478.52 for the high-pressure, 606.58 for the intermediate pressure and 711.54 for the low-pressure, giving a total indicated H.P. top and bottom of 3,591.49. This varies somewhat from what was the total of the indicated H.P. just given in detail, which was taken from the top cards exclusively, being a little less owing to the lower mean effective pressure in the bottom ends of the cylinders. Doubling this H.P. as given we get 7,183 H.P. for the total indicated H.P. of the two propelling engines.

Each end of each main cylinder is provided with a cylinder relief valve, the diameter of those for the high-pressure and intermediate cylinder being 8 in. and that of the low-pressure cylinder 4 in., the load being placed at 155 lbs. for the high pressure, 80 lbs. for the intermediate and 25 lbs. for the low pressure. Each cylinder is also fitted for 1½-in. drain cocks. All of the drain cocks of each engine discharge into a pipe leading from the fresh water side of the condenser with a branch to the bilge. This pipe has a stop valve near the condenser and has a spring check valve with hand gear which can open to the bilge discharge when the drain to the condenser is closed, but it will prevent air from entering the condenser at any time. The stop and throttle valve of the engine are in one casing, the former being 11¾ in. in diameter. The composition of the casing, as prescribed by the specifications, is 87 per cent. copper, 8 per cent. tin and 5 per cent. zinc. The casing of the intermediate valve is provided with a starting valve, the seat and valve being of composition metal, while the chest and cover is of cast iron.

The piston-rod stuffing-boxes are of cast iron, the high pressure being cast with the cylinder casing and the intermediate and low-pressure one separate. The upper surface of the stuffing-box has a recess of 1 in. in depth and 8¾ in. in diameter for the collar on the piston-rod, as shown on the longitudinal section of the intermediate and low-pressure cylinders. The glands are of cast iron recessed on the upper surface of the flange ¾ in. deep for the oil box. These glands are set up by four 1½-in. studs fitted with pinion nuts and a spur ring having a composition keeper made in halves and secured in position by four ⅝-in. studs, holding the teeth on the pinion nuts and spur ring in gear. On the inside of the gland bushing there is a groove ¼ in. deep and 1 in. long turned and connected by a ⅜ in. hole with the oil groove on the upper surface of the flange of the gland. Metallic packing is used for each stuffing-box. This consists of four composition and four white-metal wedge-shaped rings and three or more turns of Tuck's packing.

The connecting-rods with their caps and bolts are of forged steel finished all over. They are 78 in. long between centers, and are turned 7 in. in diameter at the small and 7½ in. at the large end. There is a central 3-in. hole extending from end to end. The cross-head end is forked to span the cross-head, each of these forked ends being 6¼ in. thick, faced on each side and fitted with caps bored to a diameter of 9½ in. for the brasses. These caps are 3¼ in. thick at the crown, the bolts being 3 in. in diameter over the threads, reduced to 2¹¹⁄₁₆ in. diameter for a space of 3½ in. near the head and nut. The nuts are of forged steel, each having a collar recessed into the cap and secured by a set screw and split pin at the ends of the cap bolts. At the crank-pin end each connecting-rod is increased in thickness to 13¾ in., and is bored to 18¼ in. in diameter for the brasses. The caps are 4½ in. thick at the crown, each conforming to the shape of the connecting-rod end. The bolts are 4 in. in diameter and have heads fitted with stop pins. The nuts are also of forged steel at this point. The oil hole is drilled at the lower end of each connecting-rod for the crank-pin oil pipe. The pistons are of cast steel slotted in dish form, as shown in the engravings, with a boss 10½ in. in diameter at the center for the piston-rod, with a flange and recess at the periphery for the springs, packing ring and follower. The followers are made of cast iron, with recesses for bolts. Composition bushings are screwed into the pistons and secured by ½-in. screw pins tapped for the follower bolts, these latter being of steel 1¼ in. in diameter, with square heads and set up on brass washers 1/16 in. thick. The high-pressure piston is provided with nine follower bolts. There are 14 in the intermediate and 24 for the low pressure. There is also a recess turned on the boss 2 in. long and ½ in. deep with drawing gear. Each piston has one cast iron packing ring 1½ in. thick and 6 in. wide, cut obliquely and fitted with a composition



ENGINES U. S. BATTLE-SHIP "TEXAS." VALVE FOR LOW-PRESSURE CYLINDER.

tongue. These rings are set out by semi-elliptical steel springs each 9⅜ in. long, 5¼ in. wide and $\frac{3}{16}$ in. thick at the center, tapered down to ⅛ in. at the ends. The holes for the piston-rods taper from 7½ in. to 5⅜ in. in diameter.

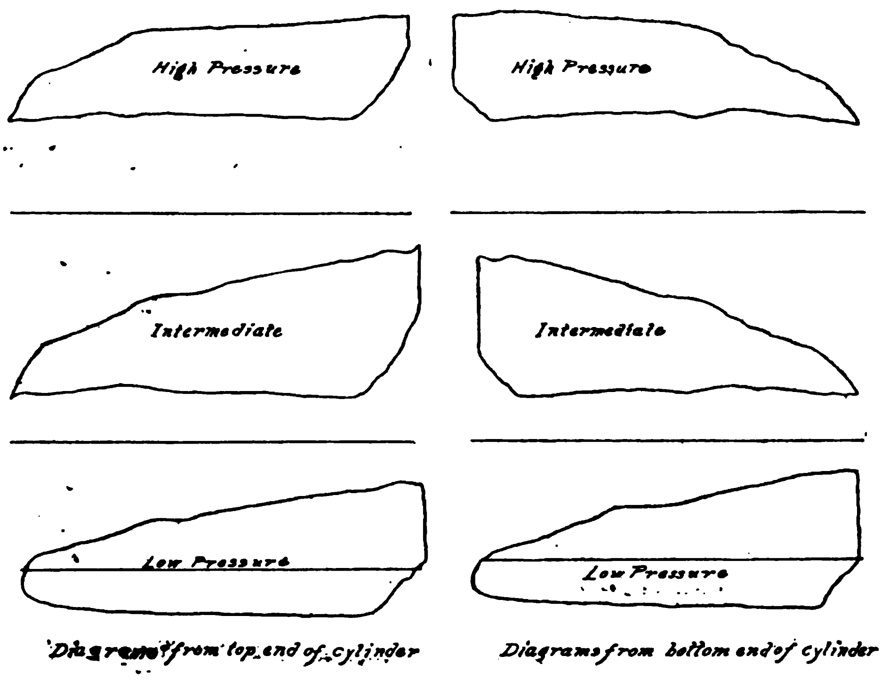
The cross-heads are of cast steel with faces 18¼ in. long and 19 in. wide, arranged to receive composition gibs. The pins are cast solid with the head, are 8 in. in diameter and 9⅛ in. long for each crank-pin brass.

As has already been said, the cylinders are carried by inverted Y cast-steel columns. These columns are of I section, well ribbed, and have lightening holes in the vertical web at such points where they could be placed. They have flanges at the top and bottom that are planed off to fit the brackets on the cylinders. These columns are secured to the brackets by eight 1⅝-in. body-bound bolts of forged steel for each flange, and to the engine bed by six 1⅛-in. body-bound bolts of the same material.

There are two lugs on each frame bored for athwartship for steel stays 2 in. in diameter, that tie the opposite frames together, also one bored face for a fore-and-aft stay 2½ in. in diameter. There are also two fore-and-aft stays passing through faced bosses at the top of the columns; these are 2⅛ in. in diameter, increased to 2½ in. where they pass through the bosses. These stays are made in two parts, connected by a 3⅜-in. turn-buckle. There are also two athwartship stays connecting supporting columns of each cylinder. These are 1⅛ in. in diameter, increased to 2 in. where they pass through the boss.

The cylinder stays consist of two 2½-in. fore-and-aft stays for each cylinder. They are increased to 2¾ in. where they pass through the faced brackets on the cylinder casings. The bed plates consist of steel castings of I section, the upper and lower flanges being connected to the web and stiffened by ribs, the engine seating being secured to the same by 1½ in. body-bound forged steel bolts.

The brasses for the crank shaft and caps are made in two parts, each 1⅛ in. thick, lined with white metal that is dovetailed and hammered in place, and then fitted with ample oil channels. They are 16⅞ in. long. Each cap and upper brass is provided with an oval hand-hole for the purpose of feeling the journal. This hand-hole has a cover with a handle, the lower part of the frame being formed into an Allen box, with perforated holes reaching to within ¼ in. of the journal. The cap bolts are of forged steel 3⅞ in. in diameter and each provided with a collar. The go-ahead guides are of cast iron 2 in. thick recessed on the back ¼ in. deep to correspond with the recess in the supporting columns for the water service. They are secured by twelve 1¼-in. counter-sunk, cheese-headed bolts. The wearing surface of these guides has a length of 55 in. and a width of 19 in. At the bottom there are two 1-in. holes fitted with composition nipples for the inlet and outlet of the circulating water. The eccentrics are of cast steel, the high-pressure eccentrics being formed in one casing, but those of the intermediate and low-pressure cylinders are separate and in two parts. The high-pressure and intermediate eccentrics have a width of 4½ in., while those for the low-pressure cylinder are 4⅞ in. wide with a recess on each side of ⅜ in. in width and ⅜ in. in depth for the flanges of the eccentric straps. These latter are of cast steel of I section and faced with composition, and are provided with lugs for the heads of the eccentric-rods and the eccentric-bolts. They have a recess at each edge ½ in. wide and ⅜ in. deep for the composition lining, which is secured to the strap by ½-in. countersunk tap screws. The two parts of the straps are held together by forged steel bolts 2 in. in diameter. They are provided with composition distance pieces fitted with thin liners. The eccentric-rods are of forged steel finished all over, having heads, and are secured to their eccentric straps by two steel stud-bolts 2 in. in diameter. The upper end of each rod is forked to span the link in the ordinary way, and is provided with the usual brass caps and bolts. The bars of the main links are 1¾ in. thick and 5 in. wide, with the pins for the eccentric-rods forged on, and finished to a diameter of 3 in. and a length of 3⅛ in. These pins are spaced 20 in. from center to center, each pair of bars being secured by three bolts 1⅛ in. in diameter. The reversing gear of each engine consists of a steam cylinder and a hydraulic controlling cylinder that are placed vertically and act directly on an arm fixed on the reversing shaft. The steam cylinder is 12 in. in diameter and the controlling cylinder 6 in., the common stroke being 17½ in. They are made of cast iron, and are placed vertically, the steam cylinder being on top.



INDICATOR CARDS OF THE U. S. BATTLE-SHIP "TEXAS."

The valve of the steam cylinder is of the piston pattern, made of composition metal working in a composition-lined valve chest. The by-pass on the hydraulic cylinder is worked by a continuation of the stem of the steam piston valve, these valves being worked by a system of differential levers, the primary motion being applied from a hand lever on the working platform and the secondary motion from a pin on the reversing arm, all parts being so adjusted that the reversing lever follows the motion of the hand lever and is firmly held when stopped. There is a stop-cock in the by-pass of the hydraulic cylinder, and a pump is attached for reversing by hand in case of necessity, with its lever convenient to the working platform. The piston of the hydraulic cylinder engine is packed by two, and the stuffing-box by one cup leather packing, the steam for the reversing engine being taken from the auxiliary steam pipe. There is one reversing shaft for each engine, made in two lengths with flanged couplings. Each shaft is of forged steel like the remaining working parts of the main engine. The exhaust pipes consist of a 16-in. pipe leading from the exhaust side of the high-pressure valve-chest, with a 16-in. branch to each end of the flanges of the corresponding intermediate cylinder. A 21-in. pipe fitted with a slip joint leads from the exhaust side of the intermediate flanges to the corresponding low-pressure flanges, and a 26-in. pipe leads from each low-pressure flange to the corresponding condenser, each pipe being fitted with a slip joint where it joins the condenser. There is a 6-in. nozzle on the exhaust pipe connecting the intermediate and low pressure for the auxiliary exhaust. The pipes are made of composition and copper.

The working platforms are located on the inboard side of each main engine between the high and intermediate-pressure cylinders. Here the revolution indicators, clock, gauges, telegraph dials and other engine-room fittings are so placed as to be in full view while working the engines. The working levers and gear on each working platform consist of one reversing lever, one starting valve lever, one lock and throttle-valve lever for reversing engines, three cylinder drain cock levers, hand levers, pump lever, stop-valve, hand-wheel, throttle-valve lever, starting valve and the stop-valve hand-wheel. The drain cock levers have spring catches, while the others have spring catches of the locomotive pattern.

All of the crank, line, thrust and propeller shafts are of steel, each length being forged solid in one piece with a hole drilled axially through it from end to end. All shafts are finished all over, and the taper holes for the coupling bolts are so drilled that the bolts drive from the forward.

The crank shafts are made in three sections for each propelling engine, and they are all alike and interchangeable. Each section has a crank of 19½ in. throw, with a coupling disk about 8 in. thick and 24 in. in diameter forged on each end. The length of each section of the shaft is 6 ft. 8 in. over all, with two journals on each end of the same, each 14 in. in diameter and 19½ in. long. The crank pins are 14½ in. in diameter and 8 in. long. The webs are 15 in. wide and 8½ in. thick, and bevelled off as shown in the longitudinal section of the engine. A 6-in. hole is bored axially through each shaft and a 7-in. hole through each crank-pin. When bolted together the cranks stand at an angle of 120° to each other, the low-pressure following the high-pressure, and the intermediate following the low pressure on the forward motion. Taper bolts 2¼ in. in mean diameter are used to couple the various lengths of crank shafts together. There are nine bolts in each coupling, all holes being drilled and ribbed to a template, so that the couplings will match indiscriminately. The thrust shafts are 13½ in. in diameter, 19 ft. 7½ in. over all and bored with 6 in. axial holes. Each shaft is provided with eight thrust collars 2 in. thick, with spaces of 3½ in., the collars being 23 in. outside diameter. On the forward and after ends coupling disks 8 in. thick and 24 in. in diameter are forged. The line shafts are each 13½ in. in diameter and 19 ft. 8 in. over all, with a 6-in. axial hole bored from the forward end to 15½ in. from the after end. The coupling disk, 8 in. thick and 24 in. in diameter, is forged at the forward end. At the after end of the shaft for a distance of 19 in. the shaft is enlarged to a diameter of 19½ in., with a coupled flange 8 in. thick and 22½ in. in diameter. The enlarged portion of each shaft has an axial hole 15¾ in. long, tapering from a diameter of 18½ in. at the after end to 12½ in. at the forward end, where it joins the 6 in. axial hole. On the inner circumference on the taper hole there are two keyways cut diametrically opposite each other, each keyway being ⅞ in. deep and 2½ in. wide. The propeller shafts are in two lengths, the forward length being 14⅜ in. in diameter and 25 ft. 3 in. long over all, while the after length is 14 in. in diameter and 30 ft. 4½ in. over all. A 6-in. axial hole is bored through the forward section of each shaft. This section is also provided with a composition casing made in three sections, which extends from 4½ in. off of the forward flange coupling to 3 ft. 4½ in. forward of the after end. This casing is shrunk and pinned on and is water-tight. The forward section of the casting is 4 ft. 9 in. long and ¹¹⁄₁₆ in. thick. The middle section is 1 in. longer and ½ in. thick, while the after section is 5 ft. 3 in. long and ⅝ in. thick. The joints lap over each other by 1 in. and are burned together. The forward and after ends of the casings are tapered for a distance of 3 in., the after end being protected by a fillet of soft solder. The forward end of the forward length of the propeller shaft is tapered to fit the taper end of the line shaft. The after section of the propeller shaft also has a 6-in. axial hole down to the point where the shaft is tapered for the propeller hub; here it is reduced to 8 in. in diameter. The after section is incased in composition ⅝ in. thick where it passes through the outboard bearing, the casing being of one length shrunk and pinned on, protected at the forward end by a fillet of soft solder and the after end being a water-tight joint with the propeller hub. The after end is, of course, fitted to the bore of the propeller shaft, and is provided with one feather key. Abaft of this the diameter is reduced to 10½ in. The propeller is secured by a cast-steel nut recessed on the face and fitted with an india-rubber ring, making a water-tight joint between the nut and the hub.

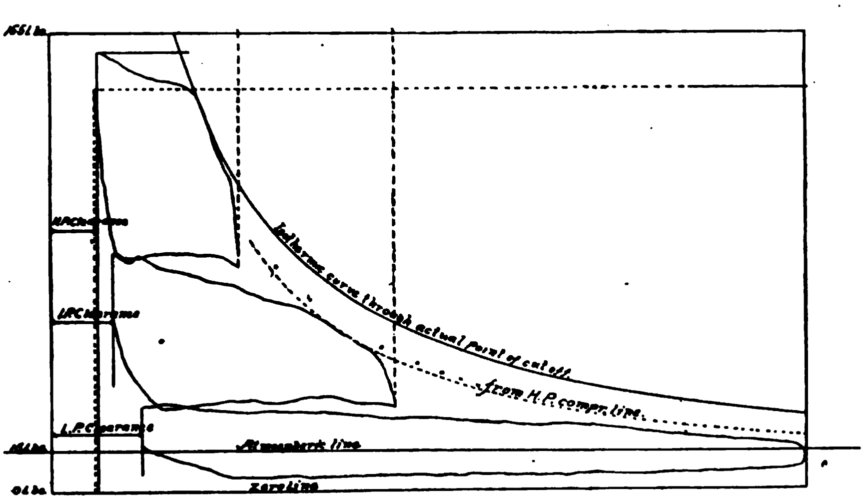
Stuffing-boxes are provided for all shafts at the points where they pass through the water-tight bulkheads. These are made of cast iron in halves, divided horizontally, and bolted together by four ⅞-in. bolts.

All parts of the machinery are oiled by closed oil-boxes, the details of which are so arranged as to be adapted to the peculiarities of this engine. They include direct leading tubes and wipers.

The thrust bearings are of cast iron with walls 1¼ in. thick, and there are seven adjustable cast-steel horseshoe thrust rings 2½ in. thick, faced on each side with white metal ⅛ in. thick, dovetailed, hammered into place and provided with oil grooves. These thrust rings are adjusted by forged steel nuts 1½ in. thick, so that each ring takes its share of the thrust. At each end of the thrust bearing there is a cast-iron bearing 15 in. long to take the weight of the shaft. Each stern tube bearing is provided with a composition lining turned to fit the tube, which is inserted from the inboard end and secured with a water-tight flange joint. This lining has an outside diameter of 19⅝ in. at the inboard end, and 19½ in. at the outboard end, with a diameter of 8 in. in the center between the bearings. The inside diameter of the lining is 16⅝ in., while the taper length of the same from the face of the inboard flange to the after end is 18 ft. 1 in. This is counterbored at each end, and each counterbore is fitted with strips of lignum vitæ fitted so as to bear on end of the grain, and smoothly and accurately bored to the diameter of the shaft casing after being secured into position. The lignum vitæ at the forward end extends 36 in. from the after end of the counterbore, and is prevented from turning by two composition strips at each end of the lining.

The propellers are of manganese bronze, the starboard one being right and the port one left-handed. They are four bladed, each 14 ft. 6 in. in diameter, cast with a pitch of 17 ft. 4 in., and adjustable from 16 ft. 6 in. to 18 ft. 3 in., the helicoidal area of the four blades being 66 sq. ft. Each blade is firmly bolted to the boss by eight 2½-in. studs with closed nuts. These studs and nuts are forged, having a tensile strength of 60,000 lbs. per square inch. The nuts are further secured from turning by ⅝-in. bronze tap bolts screwed through the top of the nut. The flange of each blade is recessed for the nuts on the studs, and has elongated stud-bolt holes to allow the pull of the blades to be adjusted. After the blades were adjusted the filling pieces were fitted into the space between the stud-bolts and sides of the holes and flanges. Each propeller is held to its shaft by a forged-steel nut screwed on and locked in place by a bronze split-pin. The shaft casing enters about ⅞ in. into the propeller, and is fitted water-tight by means of a rubber ring. Each boss is further finished at the after end by a composition cap bolted on water-tight, the bosses and caps being finished all over. In addition to the main engines there are turning engines and gear in each engine-room. This consists of a single engine for turning the main engines, which works under a steam pressure of 150 lbs. The cylinder of this engine is 4½ in. in diameter and 6 in. stroke; it drives by a worm gearing a second worm which meshes in with the worm wheel on the propeller shaft, the worm wheel of each engine being fitted on the flange coupling at the after end of the crank shaft. Piston valves are also used on these turning engines, and they are made reversible by means of a change valve moved by a screw and hand-wheel. The turning wheels are of cast steel with cut teeth, and the shafts and worms are of forged steel.

It is, of course, unnecessary to recapitulate the gauges and valves which are used on the boilers and engines for indicating steam pressure, vacuum, height of water, etc. Thermometers



ENGINE U. S. BATTLE-SHIP "TEXAS." COMBINATION INDICATOR CARD.

EXPRESS PASSENGER ENGINE FOR THE MIDLAND RAILWAY.

are placed at all points where it is necessary that the temperature of the water should be known, and revolution counters of the continuous rotary type are added to register from 1 to 1,000,000. In addition to this there are revolution counters which specifications demand should not be influenced by changes in the temperature, the vibration of the engines, or the motion of the vessel. Tell-tales are fitted on the bridge and in the conning-tower to show the direction of the revolution of the main engines, and in addition to this there is a repeating telegraph connecting the dials on the working platform with those of the conning-tower, wheel-house and bridge. Speaking-tubes connect each engine-room with each fire-room and with each other, the fire-rooms with each other, and each engine-room with the pilot-house, conning-tower, bridge and chief engineer's room. Each fire-room is also connected with the upper deck close to the top of the ash-hoist. Engine indicator connections are made at the usual points.

The engine-rooms are ventilated by means of exhaust fans, each 4 ft. 6 in. in diameter, driven by a vertical direct-acting engine having a steam cylinder 6 in. in diameter and 4-in. stroke. The air ducts that lead from these fans are provided with adjustable openings so arranged as to thoroughly ventilate all parts of the engine-room and shaft alleys, the air being discharged through ducts leading to the spar deck. Every arrangement is made for the comfort and convenience of handling and working the engines as far as the limited space will allow; but it must be remembered that in a vessel of this type, with a large H.P. to be developed, and the immense amount of machinery contained within such a small space, that every inch of room is valuable and the machinery is crowded together most compactly. Attention was particularly called to this matter when, in our issue for May, we described the feed pumps for the same vessel. Contracts for the main engines and all machinery used here described was taken and filled by the Richmond Locomotive Works, of Richmond, Va., the engines being designed at the Navy Department with the exception of a few variations which were added at the works. In a future issue we expect to describe still further some special appliances which are used in the engineers' department of this vessel.

EXPRESS PASSENGER ENGINE FOR THE MIDLAND RAILWAY.

The Dore and Chinley section of the Midland Railway has recently been opened, and this establishes a new express route between Liverpool and Manchester and Sheffield. The line passes over the peak district of Derbyshire on gradients that are very severe throughout.

The engine which we illustrate is one of the type of 20 which have been built for this special service. Fifteen of them have been built by Sharp, Stewart & Company and five by the Midland Company. The diameters of the cylinders are 18½ in. with a stroke of 26 in. The driving-wheels are 6 ft. 6 in. in diameter, and the boiler carries a pressure of 160 lbs. per square inch. The capacity of the tenders is 3,250 galls. of water.

The standard size of driving-wheels for the Midland engines is 7 ft., but these have been made 6 in. smaller on account of the gradients.

RACK RAILWAYS.

It often happens that old ideas or inventions patented many years ago, which seem to have sunk into oblivion, are half a century later revived under a new form, and become valuable acquisitions to the industrial and scientific world. Such has been the case with rack railways. The first rack railway was built in 1811 near Leeds, by Blenkinsop. It was a mistaken conception, if you like, but in it was, nevertheless, the germ of the invention which has made mountainous districts accessible by rail to tourists, and in many cases connected them with main lines. The engineers of the early part of the century were under the impression that the adhesion between the ordinary plain wheel and rail would not be sufficient to effect the propulsion of the locomotive then in its infancy. Blackett, in 1811, showed that toothed wheels and racks were needless for this purpose. Fifty-nine years were to elapse before Sylvester Marsh in the United States, and Riggenbach in Switzerland, were to revive the idea and assign it its proper place and use—namely, in those heavy gradient railways where the adhesion of the ordinary locomotive rendered it entirely inadequate to haul any load worth mentioning besides itself.

The Mount Washington Railway, built by Sylvester Marsh, is very similar to that constructed on the Righi by Messrs. Riggenbach & Naeff. It should be mentioned that Sylvester Marsh had first attempted to work Fell's central rail arrangement, but abandoned it soon, substituting for the central rail a rack. The gradients on either railway are often 1 in 4; on the average the inclination of the gradients is 11 in 50.

The Righi was a success, and since then no fewer than 25 lines have been built in the world on this principle. Most of them are met in Germany, Austro-Hungary and Switzerland. The aggregate length of these railways is over 100 miles. The gauge is either 4 ft. 8½ in. or 1 meter. Steep inclines of 1 in 5 are met with on the Höllenthal, in Germany, and the Lanfen, in Switzerland.

The rack used by Riggenbach is really a wrought-iron ladder laid centrally between the ordinary rails. It consists of parallel channel irons kept apart by stays of round iron, which constitute the teeth, into which gear the teeth of the wheels on the engine run. The first engine had a vertical boiler, forming an angle with the frames, so that the water level would remain horizontal whatever the inclination of the road might be. The wheels were loose on their axles, but the toothed wheel was keyed on the middle of the rear axle. Motion was transmitted to it by intermediate spur wheels. In subsequent applications the toothed wheels were mounted on a blind axle, for in the previous arrangement it occurred that the ordinary wheels wearing on the tread would interfere with the proper working of the toothed wheel, which gears simply with the rack. In all engines built afterward horizontal boilers were adopted, but arranged in such a manner that the level of the water should always remain horizontal, or nearly so.

The idea naturally occurred that the wheels which run on the ordinary rails might be coupled and actuated by steam. This has been done on nine of the railways built according to Riggenbach's plans. But the merit to have carried this new idea to its fullest extent and improved the rack belongs to M. Roman Abt, of Lucerne. During the last nine years the Abt system has made wonderful progress. No fewer than 19 railways have been built on the Abt system, representing an aggregate length of 194 miles. The longest are the Hartz Railway, in Germany, 18 miles; the Rama Serajewo, in Bosnia, 42 miles; a section of the Transandine, in South America, 31 miles; San Domingo, West Indies, 22 miles. One of these railways—that of Mont Salies, in France—is an electric one. One in 5 gradients, as at Aix-les-Bains, are not infrequent.

The difference between Abt's and Riggenbach's systems consists in the construction of the rack and the fuller utilization of the adhesive weight on the wheels running on the ordinary rails. There are two independent groups of cylinders. Those inside actuate the spur wheels keyed on an intermediate shaft. The outside ones drive the ordinary wheels in the usual manner, these wheels being, of course, coupled. On the portions of the lines which are not too steep, the outside cylinders alone are worked; on the heavy gradients, the inside or both inside and outside cylinders are used.

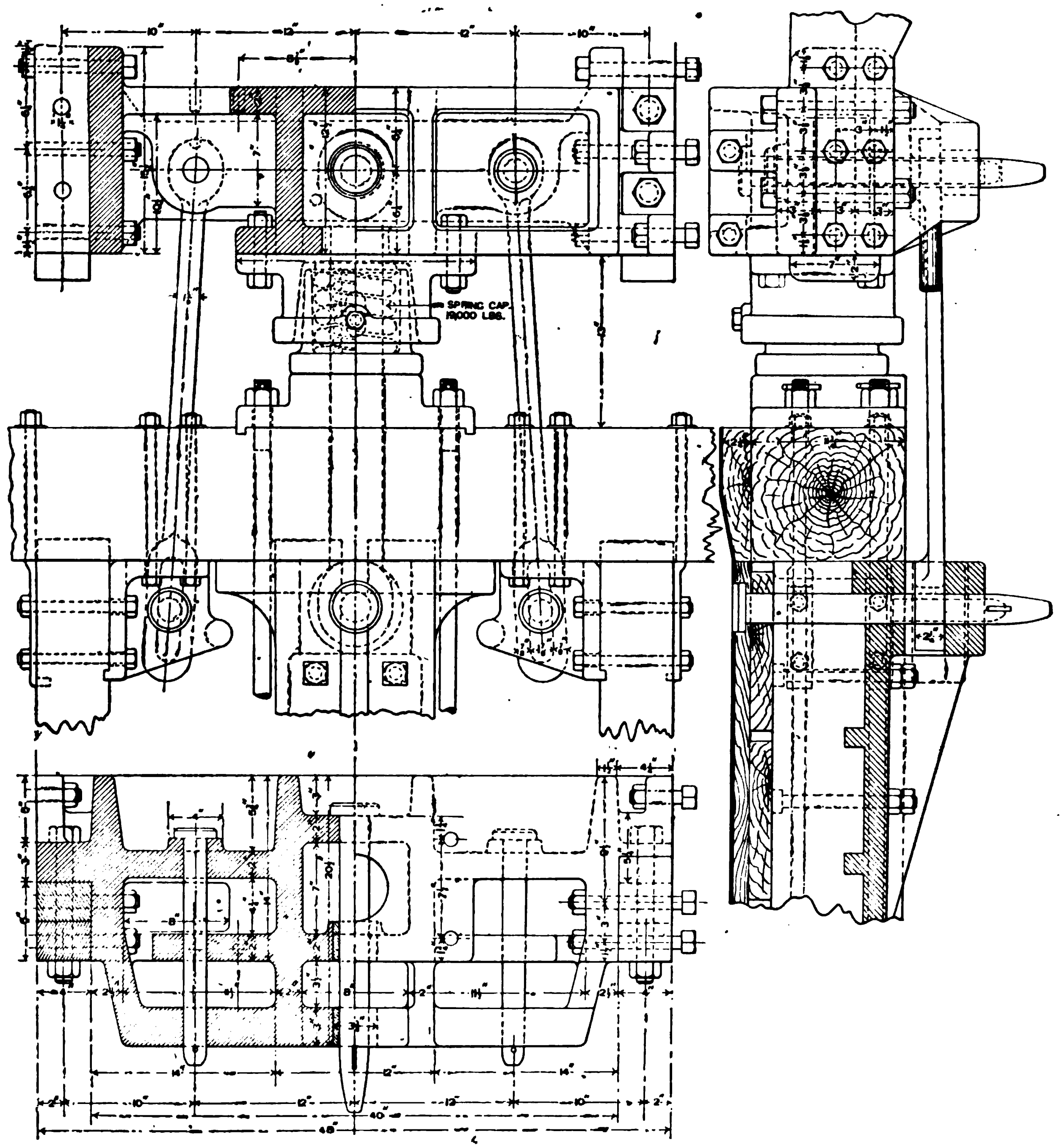
The rack consists of parallel steel bars supported by chairs resting on metallic sleepers. The steel bars are cut out so as to form suitable racks, but the teeth of one bar are not opposite those of the other, but opposite the space between two teeth of it. This arrangement necessitates the employment on the engine of wheels with stepped teeth, but it reduces friction and insures that the spur wheels are always in contact with one or two of the rack bars, which was not the case in the Riggenbach system. The advantages are: First, the rack is easier to make and lay down with accuracy than the ladder arrangement of Riggenbach. The joints, although insistent, can for each rack-bar be laid in alternate chairs, so as to keep continuity and the strength of the rack unimpaired; second, much sharper curves can be used. In the Riggenbach system they could not be less than 9 chains radius; 5-chain curves are frequent on the lines laid according to the Abt system. There is no necessity to have specially made parts for curves, as is the case with Riggenbach's rack. The slight wear which takes place on the teeth in the first days after the line is thrown open to the traffic compensates for the difference of curvature. The experience gained on the Hartz Railway goes to show that the rack teeth wear 1 millimeter in 150 years, and the spur wheels last 12 years. The Riggenbach spur wheel lasts only two years. Third, the number of rack bars determines the weight of the trains which can be hauled on such a track; a greater speed is possible, as there are always teeth in contact with the racks, and consequently no shocks, as in the Riggenbach system. Five miles an hour on the latter causes hammer blows between the wheel and rack teeth, whereas in the Abt system a speed of 15 miles an hour is obtained without shocks or noise. The Abt system has been, so far, a grand success, and it will no doubt receive more extended application. The Beyrout-Damascus Railway, 86 miles long, will be on the Abt system.—*Railway Press.*

ENGINE AND TENDER CONNECTION ON THE PENNSYLVANIA RAILROAD.

We illustrate herewith the connection between the engine and tender which has been designed for use with the Class P. locomotives on the Pennsylvania Railroad. It will be seen that there is a spring of 19,000 lbs. capacity placed in a casting located in the buffer plate of the engine. This spring is thoroughly housed in, so that there is no opportunity for it to get loose or shake out of place. The regular draft rigging consists of the usual pin connections with a bar 4 in. wide and 1¼ in. thick.

The safety arrangement consists of two bars 1⅜ in. in diameter, with slotted pin connections on the engine and a solid pin connection on the tender. This allows for curvature and the usual oscillation between engine and tender, but, should there be a breakage of the regular draft rigging, the distance traveled before the safety rigging would come into action would be but a trifle over 3 in., which is very much less than could be attained did the safety attachment consist of the chain connections.

The matter of safety connections between engine and tender was the subject of a recent report before the Master Mechanics' Association, in which great weight and great strength were recommended. This arrangement is simple, and would seem to meet the requirements as to both strength and rigidity.



ENGINE AND TENDER CONNECTIONS FOR CLASS P, PENNSYLVANIA RAILROAD.

RUSSIAN ENGINEERING NOTES.

A STEAMER FOR RUSSIAN PRISONERS.

The following description of a steamer built in Dumbarton, Scotland, for carrying Russian prisoners, will be of interest to many of our readers. The name of the vessel is *Yaroslavl* and will form a part of the Russian voluntary fleet. The length of the steamer is 420 ft. on deck, with a breadth of beam of 45

ft. The hull is of steel, and there are three decks, the rigging being that of a two-masted schooner. The displacement is 5,100 tons. She is driven by twin screws turned by two triple expansion engines. On her trial trip on the Clyde, when the draft was three-quarters of full load, her speed was 12 knots. This steamer is especially intended for the transportation of prisoners or exiles on the Sachalin Isle. Particular attention has been given to the construction of the prisoners' apartment, which is placed between the hurricane and main deck, and is so arranged that there is a passage of 1 ft. between the planking and the grating.

The openings are large and the number of ventilating tubes quite sufficient, so that an ample supply of fresh air is secured. In case of storms, when ventilators and hatches are closed, two ventilators driven by electricity are placed in operation. In addition to this, supplementary ventilating tubes are arranged for a continuous supply of fresh air. The beds are 2 ft. × 6 ft. and are arranged in two rows. The engine-room is entirely isolated from the prisoners' quarters. The cost of the steamer was £74,000.

She will sail for Odessa and then take on board 800 prisoners, and in Nickolof will take on 2,600 tons of freight for the construction of the Oussouri Railway, whence she will sail for the far east. The vessel was constructed by Messrs. Denny & Co., who have also received an order for another steamer, to be called the *Tamboff*, for the voluntary fleet. This second vessel will be constructed on the same plan as the *Yaroslavl*, but, instead of the prisoners' compartments, she will be arranged to carry emigrants, and the number of first-class cabins will be increased to 60. The contract price for this steamer is £70,000, or £4,000 less than the first one, which is said to be due to the general stagnation in the ship-building trade and great decrease in the price of steel.

THE NEW RUSSIAN IMPERIAL TRAIN FOR FOREIGN TRAVEL.

A correspondent has sent us the following description of a new imperial train for foreign travel, which has been finished at the Alexandrovsk Works of the Nicolai Railroad, in St. Petersburg:

This train consists of 11 eight-wheeled cars—viz., sleeping-car, parlor car, two grand ducal cars for gentlemen and ladies, office car, guards' car, kitchen car, car for attendants, car for electric machines, and a baggage car. The length of each car is about 63 ft., so that the whole train, without engine, is about 700 ft. long.

The peculiarity of these cars is that the bodies of them are built of steel sheets, and each side wall is made of a single sheet. The wood is used only for posts and rafters. This system is designed by Mr. Polonceau, C.E. There was great difficulty in preparing such steel sheets—55 ft. long and $\frac{3}{16}$ in. (5 millimeters) thick, which can be made at the Alexandrovsk Steel Works.

The cars are mounted on two four-wheeled bogies or trucks with a triple system of springs.

The bogies are so arranged that the wheels can be changed, so that the cars can run on Russian tracks of 5-ft. gauge and on foreign roads 4 ft. 8½ in. wide.

The heating of the cars is by steam and the lighting by electricity. The train is provided with dynamo machine and accumulators.

For the safety of travel the train is provided with three systems of brakes—the Hardy, with rarefied air; the Westinghouse, with compressed air, and ordinary hand brakes.

The inner ornaments were designed by special artists and made by the best cabinet-makers, Svirski, Bütticher & Günsberg, of St. Petersburg. The bronze furniture was made at the workshop of Berto.

All the mechanical work has been done under the superintendence of a special committee presided over by the director of the railroad department, Mr. Soumarokov.

All the cars have been sent from St. Petersburg to Warsaw, where they will be put on the foreign track (4 ft. 8½ in. gauge) and will be tried there.

SIBERIAN RIVERS AND NAVIGATION.

When the network of Russian railroads has reached the western boundary of Siberia—viz , when the Oural Railroad has been carried to Tumen on the Toura River—then the economic condition of the country and the navigation on Siberian rivers will be greatly changed.

In former times corn was produced in Siberia exclusively for local consumption; now agriculture has been very much developed, and the export of its products increases every year.

The immigration of settlers from European Russia increases prodigiously. In the year 1885 9,678 settlers passed through Tobolsk; in the year 1892 the number was 100,000; and for the whole period (1885–92) the whole number of immigrants (passing the Tobolsk Government) was 287,956.

The goods traffic through the main water ways Toura and Tobol, being the prolongation of the Oural Railroad, in the period from 1870–84 was 40,000 tons; and it has been continually on the increase, reaching 250,000 tons in 1892. The total freight traffic on the rivers of Western Siberia in 1892 was 330,000 tons.

The number of vessels (barges) on the system of the Obi River has increased with the requirements of traffic.

The first steamer in Siberia was built in 1844, and was the only one till 1854, from which time the number of steamers increased every year, and in 1893 the whole number was 102, the number of other vessels being 200.

The navigation on the Siberian rivers during the last twenty-five years has changed not only in quantity, but also in quality. In old times there were heavy vessels with great draft and small tonnage, going downward with the flow of the stream and upward by means of wire. Now we have only steamers towing the vessels (barges).

The river fleet is now the following: 1 steamer of 250 N.H.P.; 1 steamer of 180 N.H.P.; 4 steamers of 150 N.H.P. each; 8 steamers of 120 N.H.P. each; 9 steamers of 100 N.H.P. each; 18 steamers of 80 N.H.P. each; 11 steamers of 60 N.H.P. each; 15 steamers of 40 N.H.P. each, and 21 small steamers.

The greatest traffic takes place between the upper parts of the rivers Obi and Irtish from the one side, and the city of Tumen (terminus of the railroad) from the other. About all these goods are carried by the Siberian rivers the great distance of from 1,700 to 2,000 miles.

The Siberian navigable rivers being still in their natural state, navigation is dangerous, and the freights and fares are very high—seven to eight times greater than the freights on the Volga River in European Russia.

The control of the Siberian rivers from the year 1809 has been given to the X District of Way Communications. Thirteen years after, when the X district was cancelled, the control of Siberian rivers was divided between the administration of Eastern Siberia and that of Western Siberia. Since that time the administration was occupied only with highways, and nothing was done for the rivers, the control of navigation belonging to the ordinary police. In the year 1882 the administration of Western Siberia was cancelled and its water communications have been transmitted to the Department (ministry) of Way Communications. From the years 1882–93 this department has only superficially studied Siberian waterways.

Such condition of navigable rivers cannot be called favorable navigation; but the Department of Way Communications, having in view the limited resources of the State treasury, must confine the improvement of the waterways to those most necessary—viz., the rivers Yenissey, Lena, Angara, Selenga, Oussouri, while the artificial Obi-Yenissey connection will for the present be left in its present state.

Hydrotechnic works will be undertaken on the following rivers: On the Toura River, from Tumen to its estuary in Tobol; on the Tobol River, from the estuary of Toura to its estuary in Irtish; on the Tomi River, from Kouznetzk to its estuary; on the Choulim River from Achinsk to its estuary.

Besides these the channel (navigable channel) will be marked on the following waterways: Toura River, from Tumen to its estuary; Tobol River, from its estuary of Toura to Irtish; Irtish River, from Semipalatinsk to Tobolsk; Obi River, from Barnaoul to Tobolsk; Tomi River, from Kouznetzk to estuary; Choulim River, from Achinsk to estuary.

Lastly, it is proposed to build a telegraph line from Tobolsk to Krivoshchekova, the point where the future railroad crosses the Obi River (1,500 miles), and make the exact surveys and explorations of Shilka River from Svetensk to estuary, and of Amour River from the estuary of Shilka to the Khabarofka. For the control of this waterway the Department of Way-Communications appoints now administrations of water communications of Western Siberia with a territory including 5,000 miles of waterways. For the improvement of the waterways $815,000 has been appropriated, and $250,000 more will be expended each year thereafter.

THE NEW TERMS OF CONSTRUCTION OF THE GREAT SIBERIAN RAILROAD.

In one of the last sessions of the Siberian Railroad Committee, presided over by the successor to the Russian throne, Tsarevitch Nicolas, an acceleration in construction of a through railroad was decided upon. For that purpose a temporary track will be laid from Irkoutsk to Listvinichnaïa, a landing-place on the west bank of Lake Baïkal, and a regular steam ferry connection between this landing-place and the Trans-

baikal Railroad will be established. This temporary railroad, 58 miles long, will accelerate the time of opening of the through Siberian railroad, for the loop of the Baikal line located on the south bank of Lake Baikal is very difficult of construction, and will require very much time for completion. The temporary line will probably remain permanently, after the construction of the loop of the Baikal line, to supplement the navigation on Lake Baikal.

The steam ferry on Lake Baikal will work during eight months in the year, and make a good connection between the Central Siberian Railroad and the Transbaikal Railroad. But during the four winter months, when Lake Baikal is frozen and covered with ice, the transportation of goods and passengers over the ice of Lake Baikal (which is here about 25 miles wide) will be performed on sledges, or by means of a light narrow-gauge track laid on the ice.

In addition to this, a general acceleration in construction of different lines belonging to the Great Siberian Railroad was decided upon; so the Central Siberian Railroad from the Obi River to Irkoutsk, 1,167 miles long, will be completed in 1898 (instead of 1900, as was proposed before). The work will probably be executed in this time, as the local population is available for the construction of railroad works, and the materials for track-laying can be carried not only to the starting-point, Krivoshchekova, on the Obi River, but even to the terminus, Irkoutsk, on the Angara River, and in Achinsk, on the Choulim River. These two rivers, Angara and Choulim, will be improved for that purpose. The plan of construction is as follows: In 1895 the section of the Central Siberian Railroad from Achinsk (on Choulim) to Krasnoiarsk (on Yenissey), 117 miles, will be completed. The rails and other materials for this line will be carried from Tumen through Toura, Tobol, Irtish, Obi, and Choulim to Achinsk. The line from Achinsk to Krasnoiarsk being completed (in 1895), the same materials can be carried to Krasnoiarsk, and from these through Yenissey and Angara to Irkoutsk, and in 1896 the track-laying can be commenced from Krasnoiarsk and Irkoutsk simultaneously. Of course for this purpose the earthwork on the whole line will be undertaken in 1894 and completed during the first half of the year 1895.

RIVER NAVIGATION IN RUSSIA.

According to data compiled by the Russian congress of hydrotechnic engineers, the principal rivers of European Russia carry about 20,000,000 tons of freight in all. These are the official figures, but in consequence of the bad system of registration the real figures are surely double this amount. The Russian railroads now carry about 54,000,000 tons a year, so that the navigation is relatively important.

European Russia (without Siberia) has more than 35,000 miles of navigable rivers and canals, which is more than in the remaining countries of Europe, which, taken all together (France, Germany, Austria, England, Belgium, Holland and Sweden), have only 28,000 miles.

The Russian river fleet is also very great. There are 1,300 steamers, with a tonnage of about 83,000. On German rivers there are only 570 steamers, on Austrian (Danube and its tributaries) only 193. Besides those mentioned, the Russian rivers carry 21,000 other vessels with a tonnage of 6,000,000. Germany has only 18,000 such vessels whose tonnage is 1,300,000. The Donau Company, in Austria, has only 750 barges with 200,000 tons of displacement. The river fleet of Russia is therefore twice as great as the river fleet of all other European countries. The number of ton-miles made by this fleet during the half year of navigation is more than the number of ton-miles made on the railroads during the whole year. The latter in 1890 was about 8 milliard ton-miles.

The quantity of freight carried by Russian rivers (20,000,000 to 40,000,000 tons) can be compared only with that of the United States, where 60,000,000 tons are carried yearly.

GAS POWER ON TRAMWAYS.

These columns have from time to time recorded many attempts to supersede horses on tramways by some form of mechanical power. Steam locomotives, compressed-air motors, secondary batteries, cable cars, and electric underground and overhead systems have all been described. Yet, although often introduced by men of great ability and backed by ample capital, it cannot be said that any one has made an unqualified success in this country, while some have been absolute failures. The question is full of difficulties of a most formidable character. From a commercial point of view the horse is a fairly cheap motor, and anything that aspires to displace him must be at least as cheap. Further, it must not be the cause of nuisance either to passengers or to the general public. It must not occasion either noise, smell, or smoke, or be very unsightly, and it must be under perfect control. Much of the mechanical difficulty arises from the fact that some 10 or 12 H.P. must be provided to do the work of two live horses, and that, therefore, a great weight of machinery must be carried. These various requirements sadly hamper the proceedings of inventors, especially on lines where the traffic is light. Given a sufficient supply of passengers, either the cable or the trolley system answers fairly well; but the initial expenditure is so great that it is only possible when a large and steady revenue can be relied upon.

As a means of working tramways in which a large outlay is impossible, which probably means 90 per cent. of those in this country, there is being introduced by the Traction Syndicate, Limited, of 22 Chancery Lane, London, a self-contained car, fitted with a gas engine and carrying its gas supply compressed in steel tubes. Such a car is now in regular work on the Croydon & Thornton Heath Tramway Company's lines, and will be watched with great interest by all engaged in such matters. It certainly has much to recommend it. The car is not noticeably different from a horse car; it runs quietly and easily, emitting neither smoke nor steam, and is quite under control. Inside passengers can hear a slight rumble of machinery and perceive a trifling vibration, but after a minute or two these are unheeded, and practically there is nothing to detract from their comfort. Neither they nor bystanders in the street can perceive any machinery whatever, for the engine and gearing are entirely enclosed, the motor lying under one seat and the wheels and clutches under the floor of the car. The driver stands on the end platform with the usual brake handle beside him, and in front of him a lever which operates the clutches controlling the gearing. With the lever vertical the engine is out of engagement with the axles; when the lever is placed to one side or the other the slow or the fast gear is in engagement. There is a second lever for operating reversing clutches at the end of the line.

The motor has two cylinders placed face to face at opposite sides of the crank shaft and both driving on to one crank. At one end of the shaft—that nearest the side of the car—is a flywheel, and at the other end a pinion gearing into a wheel on the first motion shaft, which lies under the floor of the car. On this shaft are two pinions, either of which can be made to drive a second motion shaft, the large pinion giving a speed of 8 miles an hour to the car and the small pinion half that speed. Each of these pinions is furnished with a friction clutch consisting of two disks, with a ring of beechwood between them. One disk is set up toward the other by means of bell cranks and spring toggle arms pivoted to a sliding collar, the arrangement being such that when the clutch is in engagement the pressure of the arms is about at right angles to the shaft, and there is no end thrust on the sliding collar. The second motion shaft is geared to the axles by pitch chains. For driving in the opposite direction the rotation of the first motion shaft is reversed by intermediate wheels and claw clutches.

Many of the difficulties connected with a gas-driven car arise from the fact that the engine must not be stopped *en route*, but must run constantly, whatever the car may do. It is, however, susceptible of a certain amount of regulation, and advantage has very ingeniously been taken of this to save gas and to lessen vibration. When the work is light the governor cuts off the gas supply to one cylinder entirely, the other doing all the work. The governor is loaded by a spring on the spindle and also by weights on an external lever, and these weights can be lifted by the same handle that operates the clutches. By this means the speed of the engine is reduced by some 50 per cent. when the car is standing, and, further, the gas admission is delayed until half stroke, with the result that the explosion is rendered much more gentle and less likely to give rise to vibration of the car. The gas is carried in three receivers under an initial pressure of 120 lbs. to the square inch, enough being taken for an 8 to 10-mile run. It is compressed at the Thornton Heath depot by a gas engine and pump, and is kept in a receiver under a pressure of 10 atmospheres. The compressed gas is carried to the car by a pipe and flexible hose, the charging occupying no more time than changing horses. We are informed that the consumption is 25 cub. ft. per mile at the cost of a penny.

The performance of the car is quite satisfactory. It carries 28 passengers in all, and makes a very fair speed, the limit allowed by the Board of Trade being 8 miles per hour. With the slow gear it will readily mount an incline near Thornton Heath Station of 1 in 23, with a short piece of 1 in 16, and in coming down it can be stopped by the brakes in its own length. It also goes round a curve of 35 ft. radius on a 1 in 27 grade. Its weight, filled with passengers, is 5¼ tons. The future of

the system turns mainly on the question of maintenance. The first cost of the car with its motor is not greatly different from that of a horse car with its 11 horses. For gas it costs 1*d.* per mile against 3½*d.* per mile for fodder and bedding for horses, so that it starts with an advantage of 2½*d.* per mile. Time must decide whether horseflesh or mechanism is the cheaper to keep in going order. The new motor has, at least, one great advantage over the tramway steam locomotives which, in some districts, have done good service—it has no boiler to be constantly under repair. There are £14,000,000 sterling invested in tramways in the United Kingdom, with very unsatisfactory results as to dividends, so that evidently there is a wide open ing for any system that would effect an economy in working. —*Engineering.*

RAILWAY CONSTRUCTION IN JAPAN.

On the occasion of the World's Fair much had been made known about Japan and the habits of the people. The country is undergoing great social, commercial and political changes, and is making rapid strides in improving her means of communication and public works in general. The first railway was commenced in 1870, and there are now more than 1,900 miles of railways working, besides several lines under construction or proposal, which are as follows :

Names.	Length of Lines Granted.	Lines Open.	Lines under Construction.	Lines Surveyed.
	Miles.	Miles.	Miles.	Miles.
Imperial Government Railway..	557.61	557.61	......	......
Niphon Railway Company.......	598.24	593.08	5.16	......
Sanyo " "	307.92	145.10	9.65	153.17
Kinshin " "	272.52	136.76	53.50	82.26
Tanke " "	205.09	205.09	......	......
Kansei " "	90.25	59.06	23.50	7.69
Chikuho " "	29.00	25.66	3.34	......
Osaka " "	42.18	32.69	6.21	3.28
Ryomo " "	52.21	52.21	......	......
Kobu " "	26.90	22.96	3.94	......
Hankai " "	6.16	6.16	......	......
Sanuki " "	10.19	10.19	......	......
Kushiro " "	25.86	25.86	......	......
Iyo " "	10.24	7.43	2.81	......
Sobu " "	40.00	......	5.50	34.50
Bantan " "	30.71	......	30.71	......
Nara " "	25.66	......	25.66	......
Sangu " "	22.50	22.50	......	......
Nanwa " "	16.50	......	16.50	......
Kawagoe " "	18.25	......	18.25	......
Settsu " "	14.43	......	14.43	......
Boso " "	11.49	......	11.49	......
Sano " "	9.63	9.63	......	......
Ome " "	13.09	......	13.09	......
Hoshiu " "	43.81	......	43.81	......
Shinkaku " "	17.40	......	......	17.40
Ota " "	18.00	......	......	18.00
Nanyo " "	7.13	......	......	7.13
Dogo " "	2.29	......	......	2.29
Total..........................	2590.26	1911.99	287.55	390.72

The standard gauge of Japanese railways is 3 ft. 6 in. The permanent way consists of flat-bottomed steel rails weighing 60 lbs. per yard, laid on cross-sleepers, except 66½ miles for Tokyo-Yokohama and Kobe-Kyoto lines, on which double-headed rails on cast-iron chairs are used. On the Kobe-Kyoto lines cast-iron pot sleepers were first tried, but they were gradually replaced with timber cross-sleepers. Lately, an experiment was made with earthenware sleepers in the Shinbashi station compound. As there is an abundant supply of wood in Japan, and it is not attacked by insects, timber sleepers answer very well. The railways are mostly single lines, with the following exceptions :

Shinbashi-Yokohama Line,	18 miles	(double line).			
Numadzu-Oyama	"	22	"	"	"
Ueno-Omiya	"	16½	"	"	"
		56½	"		

The above lines are entirely double-tracked. The earthwork for Kobe-Kyoto Line (47½ miles) is made for a double way and the bridges single way. All other lines are entirely single lines. Figs. 1 and 2 show the earthwork for single lines. There are 430 stations, of which Shinbashi, Yokohama, Kyoto, Osaka, Kobe, Hiogo, Moji, Yokkaichi, Tsuruga, Naoetsu, Ueno, Omiya, Awomori, Temiya, etc., are large stations. These are mostly of wooden buildings, but some are of brick and stone work with iron roofs. There are extensive workshops of the Imperial Government railways in Shinbashi and Kobe, where locomotives and cars are built and repaired. The locomotives are mostly of English manufacture, but there are some American and German locomotives, as well as of Japanese make, the total number for the whole 1,900 miles being 840. The ruling gradient is 1 in 40 (2.5 per cent.), and the sharpest curve, 15 chains.

As the country is mountainous and full of rivers and running streams, there are several engineering works—deep cuttings, high embankments, tunnels, bridges and culverts. In order to carry out earthworks, temporary rails are used. The Japanese coolies are not at all accustomed to use wheel-barrows, but they are well trained to carry earth, stone, or anything on their shoulders with straw net or *mokkō*. In blasting rocks, gunpowder, dynamite and other explosives are used.

Bridges consist mostly of wrought-iron plate or Warren girders, except some brick arches, which are usually constructed in a deep valley or for flood-openings. The usual span of plate girder is 40 ft., and that for Warren girders is 100 ft. But in large rivers, where longer spans are required, Warren girders of 200 ft. span are constructed. The superstructure is of an ordinary character, as shown in fig. 3. When the ground is of a substantial material, concrete foundation is made and masonry piers are built, but in case of soft material usually brick walls are sunk, though cast or wrought-iron piers (from 3 ft. to 8 ft. in diameter) are sometimes constructed. While iron is required to be brought from Europe, bricks are manufactured in every part of the country ; thus the latter is preferable in Japan. The brick cylinder foundations for large bridges are constructed in the following way : The wells are usually built to rest on hard stratum, in two columns, 12 ft. in external diameter and 2 ft. thick, differing in depth from 30 ft. to 90 ft. below river-bed, according to the nature of the bed. Through the whole height of the cylinder tie bolts run, and they are fastened to the curb-shoe, whose outer side constitutes a cutting edge. Below the ground level the diameter of the wells is reduced to 8 ft., and it is filled with concrete. From this level, masonry works are carried up to the outside of the girders. The space between the two cylinders is arched over, and an intermediate wall is constructed. To sink the wells, first the brick-work is built on the curb-shoe, which is already placed in its position. A pair of the cylinders forming one pier is usually sunk alternately so as to avoid any great difference of levels of the wells and consequent divergence from the vertical plane. In order to excavate inside the wells, Milroy's, Webb's, and Bull's dredgers were tried, of which the last proved most suitable for its simplicity and ease of using. But in case of gravel bottom it is objectionable on account of stones being caught in the jaws of the dredger, which causes difficulty and prevents it from being pulled up without the contents being run out. It is usual to employ a simple hand dredger made by a contractor, which is skillfully handled by Japanese workmen. When the cylinders are sunk to proper position they are filled with concrete.

The best season for sinking the foundations is from October to the following May, which is the time when the autumnal floods set in and the vernal floods begin from the thawing of ice and snow in the mountains.

It will be interesting to notice the cost of some large bridges on Japanese railways, which are as follows :

Names.	Length in Feet.	Total Cost.	Cost per Running Foot.
		Dollars.	Dollars.
Rokugo-gawa Bridge (Tokaido Line).......	1,650	434,906	263.58
Banew-gawa " "	1,368	77,682	56.79
Fuji-kawa " "	1,874	283,360	151.21
Abe-kawa " "	1,830	80,874	44.19
Oi-gawa " "	3,339	409,216	122.56
Tenriu-gawa " "	3,967	507,055	127.82
Hamana No. 3 " "	1,578	64,976	41.18
Yahagi-gawa " "	1,139	64,978	57.04
Kiso-gawa " "	1,874	302,286	161.31
Nagara-gawa " "	1,490	204,271	137.09
Yebi-kawa " "	1,055	181,545	172.08
Aichi-gawa " "	1,305	56,767	43.50
Nosu-gawa " "	1,769	82,683	46.71
Seta-gawa " "	1,450	88,024	60.71
Katsura-gawa " "	1,197	261,633	218.57
Upper Kanzaki-gawa Bridge "	1,297	283,415	218.52
Lower " " "	1,187	279,921	235.82

The tunnels of Japanese railways are usually for a single line, except some short tunnels (on Kobe-Osaka Line) under rivers whose beds became elevated above the surrounding grounds by the deposits of materials brought from the source. The cross-section is shown in fig. 4. Generally the width of springing

of arch is 14 ft., and the height from rail level to soffit of arch is 14 ft. In the Usui-Toge Railway these dimensions were made 15 ft., as a larger locomotive of the Abt system was designed for that steep railway. The tunneling may be briefly stated as follows: At first the top headings of 6 ft. × 5 ft. are made. Then the excavations to the full dimensions are carried on. This is done both by rock drills and hand workings. The archings of the tunnels are from 2 rings to 6 rings, according to the nature of the rock, and below the springing, side walls are built, their back being well rammed with concrete or gravel puddle. Ventilation is kept by means of fans working at the end of a long wooden tube with closed doors. The portals of the tunnels are well constructed with stones and bricks.

The following list gives cost of principal tunnels:

NAMES.	Length in Feet.	Total Cost.	Cost per Running Foot.
		Dollars.	Dollars.
Hakone-yama No. 2 Tunnel (Tokaido Line)	1,892	115,573	61.09
" No. 3 " "	1,024	61,472	60.03
Ishibe " "	2,865	131,411	45.87
Isohama " "	3,167	210.873	66.58
Makinohara " "	3,273	213,617	65.27
Osaka-yama " "	2,181	203,264	93.20
Nakoe Tunnel (Yokosuka Line)........	1,130	34.809	30.80
Numama " "	1,319	41,795	31 69
Yanagase-yama Tunnel (Tsuruga Line).....	4,425	425,499	96.16

rikisha (a carriage drawn by a man) is used, which was shown in the Chicago Exposition. The jinrikisha has also been introduced into China and India from Japan. In this way manual power is still being used for some other works. It is known in America that machine is ultimately cheaper than animal or man power. In Japan, too, the latter is gradually being replaced by the former.

The motive power at present used in the country is as follows:

Steam-power, 38,000 H. P.	General workshops,	26,000 H. P.
	Mining,	12,000 "
Water-power, 5,700 H. P.	General workshops,	3,100 "
	Mining,	2,600 "
43,700 H. P.		

In the above figures the power used for the propulsion of railway cars and steamships is not included. As there is a convenient supply of water in mining districts, water power is generally used there. In countries like Switzerland and Japan, where there is a natural supply of energy, it is economical to utilize it, especially with the aid of electric motors. It is owing to the advancement of electrical engineering that this problem is now entering into the field of practical engineering. Thus, water-power can be derived in a great many different ways—*i.e.*, from the most primitive form of water-wheel, having only two buckets—still to be found in some country districts of Japan—to the great installation of turbines and dynamos at the Falls of Niagara. An example of an artificial canal for deriving water-power is seen in the Kyoto Canal Works, which were illustrated in THE RAILROAD AND ENGINEERING JOURNAL for March, 1891. This work is calculated to produce 3,000 H.P.

EMBANKMENT

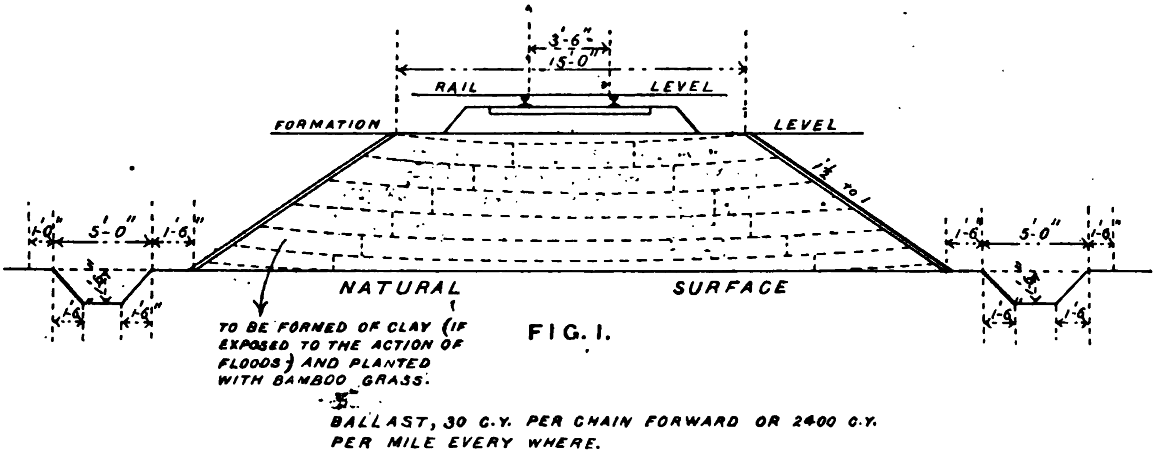


FIG. 1.

CUTTING

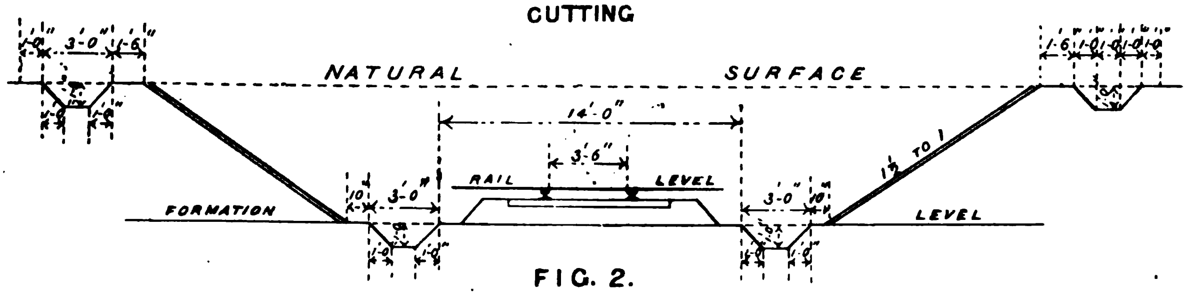


FIG. 2.

Of the average cost of one mile of Japanese railways, it may be mentioned that for the Imperial Government railways the cost (an average for 557.61 miles) is $63,475, and for the Niphon Railway Company the cost (an average for 593.08 miles) is $33,468. The former has more bridges and tunnels than the latter. For all other private lines a fair average cost per mile may be said to be from $45,000 to $50,000. The traffic receipts of the Imperial Government railways is $150 per mile per week, and that for the Niphon Railway Company, $90.

MOTIVE POWER IN JAPAN.

The Japanese islands are generally within the easy reach of steamers, and there are main trunk lines of railways almost completed with roads connecting important towns and localities which are gradually improved. In some cities and towns there are tramways. But in every part of the country jin-

Although in Europe and America coal is generally found in the carboniferous strata, it is not the case in Japan. It is seen from the marine nature of the strata that some parts of the country were sunk beneath the primeval ocean, and had not land for dense vegetation. In rocks of the Mesozoic era, which follow the carboniferous strata, some coal seams are found, but they are not valuable. In the Cainozoic strata, especially associated with tertiary formation, there are many important coal fields which are scattered in various parts of the country. Among these fields, those in Hokkaido and Kinshin are most productive, the rich seams being from 4 ft. to 8 ft. thick. In these coal districts coal-mining has been established and railways built, and they are working with great success.

The total annual production of coal in Japan is 3,000,000 tons. Out of this amount, 120,000 tons are used for railways, 530,000 tons for steamships, 520,000 tons for workshops, 480,000 tons for manufactures of salt, and the remaining 1,350,000 tons are exported to China, India, America, etc.

Besides being derived from coal, power has another source, namely, forests, from which wood and charcoal are obtained. The quantity of wood which is consumed as fuel and charcoal in Japan is enormous, amounting to 47,400,000 tons per year. Out of this amount, 40,000,000 tons are for domestic use, 650,000 tons for the manufacture of tea, 1,900,000 tons for the manufacture of silk, 4,850,000 tons for mining and smelting

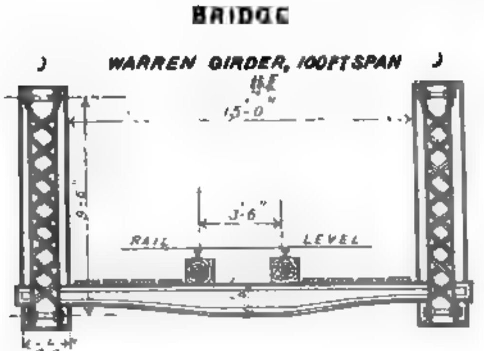


FIG. 3.

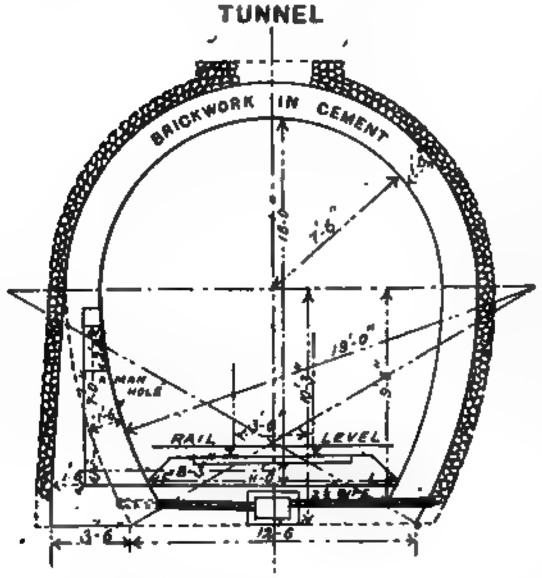


FIG. 4.

works. Thus the forests are the principal source of heat and power in Japan. But it is a well-known fact that to destroy the forests of a country is to destroy its rivers, so that proper care is now being given to them. There are good forests in Central Japan and thick forests in Hokkaido, which are not within easy reach from harbors or railways. If railways be constructed for facilitating the transportation of wood in these forest districts, there will be great advantage. It is hoped that these three elements of power—*i.e.*, water, coal and wood—will be utilized so as to meet the requirements in various parts of the country.

THE MOTIVE POWER REQUIRED FOR AN ELECTRIC RAILWAY.

L'Électricien recently published a long article on the electric railway running from Lyons to Oullins, in France, in which a calculation was made of the motive power required on an electric tramway using the overhead trolley wire. The first step to be taken is to settle upon the frequency with which cars are to start from the two ends of the line, as well as the maximum and average speeds to be maintained. When this is laid down graphically the number of cars in service can be readily deduced. The calculation of the motive power required for each car for the round trip is based upon the estimate of 20 lbs. per ton for resistances on a level track, and 10 lbs. per ton for each 1 per cent. of gradient, and finally by adjusting the power required so as to adapt it to the speeds of the car upon the grades and level stretches. If then we apply the formula that is applicable to the different points along the line, it will be easy to construct a polygon whose area will be enclosed between lines that represent the amount of work required to keep the car in motion. By referring this to the graphical representation of the running cars it is possible to determine the amount of power required by each car at each instant, as well as the total power required by the whole number of cars at the same instant. If the matter is carefully done these calculations should be made at one minute intervals for a round trip. In this way we will find the maximum, the mean, and the minimum power required, it being possible that the last may be zero. The figures thus obtained only indicate the power which must be applied horizontally to the axles of the cars. In order to obtain the power which will be required at the station we must take the efficiency of the different portions of the system into account, and this may be rated as follows: Motors and gearing, 70 per cent.; line, 90 per cent.; generating dynamo, 90 per cent.; steam-engine and belting, 85 per cent.; giving an average efficiency of 48.2 per cent. We may, therefore, consider that we utilize about 50 per cent. of the H.P. indicated at the cylinder of the engine.

Practically these calculations are very quickly made, because experience has shown that a certain number of kilowatts will be required for a given number of cars, and that almost entirely independent of the profile. The following figures may be taken as typical:

Generating dynamo, 60 kilowatts, 4 cars.
" " 100 " 6–7 "

It may be readily understood why this should be the case, because when there are up grades in one direction they become down grades on the return trip, and the car will require no current while running over them. The calculations will be very nearly exact, for no account is taken of the times when the current is shut off. It is admitted, too, that it takes as much current to bring a car from a standstill up to speed, as it does to ascend a 3 per cent. grade at a speed of 7½ miles per hour. In any case the figures obtained by this method of calculation are valuable, because they show the great variations in power that may occur, and that the regulation of the steam-engine should be very sensitive in order to meet the sudden variations in load to which it is subjected. In fact, it is not an uncommon thing in the central stations of electric tramways, to have the needle of the ampère meter vary suddenly one way or the other by as much as 150 ampères. It is, therefore, desirable to know the relationship that exists between the maximum and the mean motive power. If this ratio rises above two, as occurs in lines running only four or five cars, the best steam-engine to use is one of the high-speed type, having a very heavy fly-wheel. The advantage of using a high-speed rather than a low-speed engine for such work as this is, of course, apparent to any one who will think about it. For however sensitive the valve regulation may be in fixing the point of cut-off, it acts upon the admission valve and can only make its influence felt near the beginning and end of the stroke; hence, it is certainly more rapid in an engine making 250 revolutions per minute than in one making 60.

When the ratio of maximum to average power is included between 1½ and 2, as when from six to eight cars are run, a slower engine can be used if it is provided with a very heavy fly-wheel. Above eight cars the best engine to use is one of the Corliss type, for the suddenness of the variation from maximum to minimum is greatly reduced.

These opinions have recently been confirmed by a visit to a central station of an electric railway, where a dynamo of 50 kilowatts nominal power at 600 revolutions is driven by a steam-engine running 120 revolutions per minute. The fly-wheel of the engine is very small, both in diameter and weight; under these conditions it is easy to detect a variation of 50 per cent. in the speed of the engine, which occurs at regular intervals corresponding to the stopping and starting of the cars; yet the stops being fixed, and none being made on signal, the variations in the work to be done are not as great as would occur under other conditions.

The power for running the Lyons-Oullins Railway was calculated in this way, and it was found that from 120–160 H.P. would be required at the central station in order to operate from six to eight cars. Under these conditions an engine of 150 H.P. was required, with a capability of rising to 200 H.P. for short intervals in case of necessity.

TRANSMISSION OF POWER, WITH AN ANALYSIS OF COMPOUND AIR COMPRESSORS.

By A. E. Chodzko, M.E.

GENERAL REMARKS ON THE TRANSMISSION OF POWER.

The transmission of power ranks among the most important subjects which have, during the past thirty years, engaged the attention of the engineering profession. This problem, in whatever particular form it occurs, can always be reduced to the following general terms:

To convey and distribute a certain amount of power which can be more conveniently generated at some distance from the points where it is used than it would be in their immediate vicinity.

This class of questions is a direct outcome of the fact, which needs no demonstration, that a large aggregate power, if generated at a great many different points and in small amounts at each of them, is more expensive to produce than if the whole was generated in a single motor. Such is the origin of the central power station, and the problem is: How to convey power therefrom, either to a number of different places or to one other single place. Any practical answer to this question constitutes a system of power transmission.

A system of power transmission is essentially formed of four distinct elements:

1. A generator of power, situated at a central station.
2. An active medium wherein this power is concentrated, whose object is to transfer it to its destination.
3. A conductor or passive conveyer of this medium.
4. Motive apparatus to utilize the conveyed energy.

It is not the intention to enter into a detailed study of the various systems of power transmission; both the quantity and the nature of the problems involved in such a work exceed the scope of the present paper, and only an outline of the subject will be offered.

Six principal mediums of power transmission are known at present whenever the distance between the generator and receptors exceeds the limits of a factory. These are: (1) Traction by wire rope; (2) water under pressure; (3) steam; (4) gas; (5) electric current; (6) compressed air.

The generation of power is effected either by steam or by a fall of water; in gas transmissions heat is also a primary agent. But if one considers the correlation between the velocity of motion in these various mediums, over conductors, and the size of these conductors, a distinctive line may be drawn between the rope system and the five others—namely, in the former the velocity with which the active medium is carried over a conductor does not in any way affect intrinsic energy. In other words, a pull, or tractive effort of 100 lbs., exerted at the generator end of a teledynamic transmission, would be integrally conveyed by the rope to the receptor end, whatever be the length and the size of this rope, and also the rapidity of conveyance, if there were no intermediate sheaves between the two ends of the rope. The resistances due to the friction of sheaves or to the flexure of the rope would be concentrated at the terminal sheaves, but not generated at the conductor.

The result is that a high efficiency is not only consistent with high velocity and a small conductor, but within the limits of safety and of resistance; such are the very conditions of high efficiency in a teledynamic transmission, because a high velocity of motion means a small tractive effort for a given power, and consequently diminished friction in their bearings, and a reduced size of rope proportionally reduces stiffness or resistance to bending.

Some remarkable applications of this system have been in successful operation for a number of years past. More recent and no less important illustrations are found in the cable roads and in the various systems of aerial ropeways for transporting ore and the like.

Taking now the five mediums for transmitting power, one finds water, steam, gas and compressed air. The energy of these mediums obtainable at the points of application, compared with energy at the generator end, is directly affected by the size of the conductors and the rapidity of motion of the active medium, and the resistance occurs on the whole length of the conductors, increasing with their length; here a condition of high efficiency for a given power and a given size of conductor is, that the velocity of the active medium be limited to a point beyond which this efficiency falls rapidly.

The resistance to the free flow of an electric current is also greatly affected by the size of the conductor, and varies inversely with the size, and proportional to the length.

The above distinction between the first system and the five others should not be construed as a criticism of the general efficiency of each system, but only as a peculiar feature inherent to the different natures of the active mediums.

Present knowledge of the subject does not permit us to formulate limitations of distance to which the power can be transmitted. We are no doubt on the eve of important developments in this respect, and the results of the contract between the Niagara Cataract Company and the State of New York for a 300-mile electrical transmission will be eagerly watched by the engineering world. What the future has in store from the discoveries of Nikola Tesla and others is now a matter of speculation.

So long as the distance is not great between a generator and the receptor, any one of the above systems may be applied. No absolute rule could be given suitable to all cases, as a guide in the selection between them, because no such rule exists; the distance of transmission is but one of many conditions to be considered. There are cases in which water has an uncontested superiority over an elastic and compressible power medium.

The following statements are therefore applicable to the general problem of power transmission, and remain open to possible exceptions.

When the distance is 3 or 4 miles, the choice between the systems of power conveyance is narrowing down, and when power is to be transmitted 10 or 20 miles, electricity and compressed air appear to be the most advantageous. One class of applications exist which have been the subject of exhaustive experiments and have furnished some highly valuable and positive data—the distribution of power over a concentrated field, as in cities.

In this case the central station and each receptor are not connected in the most direct way, but a main conductor is spread out into branches involving numerous changes in the direction of the course or flow. These circumstances render rope transmission impracticable. Water is also unsuited on account of the loss of pressure and contraction of the passages. The danger of frost is also an impediment in most places. The choice is therefore between steam, gas, electricity and compressed air.

Changes of temperature have much influence upon the energy of steam, while gas, electricity and compressed air are unaffected by temperature. But aside from this fact, which is a serious objection to steam transmission, all fluids under tension confined within conductors are liable to escape and waste, causing a direct loss. In the case of steam such loss occurs by leaks and heat radiation. With gas, by leaks only. With electricity, all over the conductor if a contact occurs with some other body. With compressed air, by leaks only.

Complete insulation of the conductor is required in electrical transmissions; with air and gas the joints alone have to be guarded. Steam requires both close joints and insulation or covering to prevent radiation.

The effects of leakage, besides the loss of energy, involve personal danger, damage to surroundings and property by heat and moisture, eventual danger of fire. With gas, there is danger of personal injury, danger of fire and explosion. With electricity, danger of personal injury, serious danger of fire if contact exists between conductors and their surroundings. With compressed air, no bodily injury, no danger of fire. The pre-heater used in connection with the receptor is a small apparatus under easy control, because it is in operation during working time only. In this respect c mpressed air is distinctly superior to other mediums of transmission.

Investigating next what becomes of the transmitting medium after it has performed its work, one finds: Steam has to be condensed or conducted into the atmosphere clear of all surroundings. Gas is deleterious, and must also be conducted clear of surroundings. Electricity has no objectionable effects so long as insulation is effective. Compressed air produces beneficial effects by a supply of fresh air in the premises, and by utilization for various purposes.

One feature wherein compressed air stands above all other means of power conveyance is in the possibility, when employing proper apparatus, of obtaining a practically perfect working efficiency. The result is mainly due to the fact that it is possible to introduce additional energy before using in a motor or engine, and this is done with no objection or expense worth considering. Compressed air, therefore, presents more elements of economy, safety and convenience than any other medium of power conveyance in a city or circumscribed district. From the consumer's standpoint its advantages are even greater than the engineer's.

Experience has shown that an air motor will start instantly after any length of stoppage, which is seldom the case with a steam engine, and still less with a gas engine. The absence of the noise and offensive odors is a great advantage, also the saving of space and the reduction of insurance rates makes an

air motor a typical one for small industries, especially for work carried on in workmen's houses or small workshops. The origin of fires in industrial buildings is commonly traced to a boiler-room in the basement.

In addition to transmitting power, the exhausted air can either remain at the outside temperature and ventilate a room or shop where the work is done, or in the cold season the fresh air, by adjustment of the point of cut-off, can escape at any warmer temperature desired.

On the other hand, as pointed out by Professor A. W. B. Kennedy, is the case of a Paris restaurant where compressed air, after actuating an electric-light plant, was exhausted through a brick flue into the beer cellar; in this flue the carafes were set to freeze, and large molds of block ice were made for table use, while the air was still cold enough in passing away through the beer cellar to render the use of ice for cooling quite unnecessary even in the hottest weather.

The advantages of this mode of power transmission, it is strange to say, are little known, and erroneous ideas prevail about the efficiency of air as a motive medium.

AIR COMPRESSORS.

Up to a comparatively recent date, applications for compressed air were confined to mining and tunnel works, mainly in rock drilling, and less frequently in driving underground hoisting, haulage or ventilating plants. As a rule all the machinery constituting the motive machines employed was of the crudest and most uneconomical description. In both rock drills and underground engines the air was used with little or no expansion, and allowed to escape at a high pressure.

In the course of his investigations on the subject of power transmission, Professor Riedler quotes the efficiency of small mining plants as reaching only 10 to 15 per cent. of the power applied to the compressors. Even in large tunnel works, where high-class single-stage compressors were used, the proportions of 22 to 32 per cent. were for a long time considered as the best efficiency obtainable in the practice, according to whether the air pressure was high or low, and the logical conclusion of this was that low air pressure was an element of high efficiency.

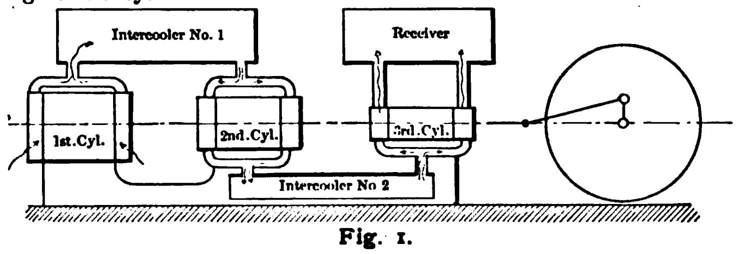


Fig. 1.

The heating of the air prior to its use in engines permitting complete expansion led to a high initial pressure, since a given amount of work became available from a small volume of air.

Such high pressure permitted smaller mains for conveying the air from the compressors to the motor—another cause of economy in first cost of air-transmission plants—but this economy could not have been maintained through the whole system with single stage compressors, or when compression is performed in one cylinder. Experience has shown that while $p\,v\,1.4$ = constant is the symbol of adiabatic compression, and $p\,v$ = constant, the symbol of isothermal compression, the most perfect cooling arrangements used in air compressors cannot give a better result than $p\,v\,1.2$ = constant. A single stage compressor with spray injection shows 0.845 as the highest attainable efficiency for seven atmospheres absolute, the efficiency of an isothermal compressor for the same terminal pressure being 1.

What preheating had done at the motor end of the transmission was effected at the generator end, although to a less degree, by the multiphase expression—*i.e.*, by compressing successively into several cylinders, and also by the use of a positive motion of the valves. This class of machines, known by the name of compound compressors, must be considered as an essential and imperative element in the compression of air. The efficiency of a triple compound compressor for the above-quoted terminal air pressure would be found equal to 0.95.

It may be safely asserted that except for moderate pressures, or when the question of economy of power is clearly superseded by considerations of first cost and the simplicity of the plant, the compound machine must be regarded, not as it often is, an object of unnecessary perfection, but as the rational type of modern compressors. This fact had been recognized by the pioneers of compound compression in America, the Norwalk Iron Works of South Norwalk, Conn., and it is creditable to them to have pointed out, at a time when this subject was imperfectly known, that the exception should be the single and not the compound compressor.

It has been thought that a summary of the principles of compound compression would prove of interest, and it is the subject of the second part of the present paper. While the use of thermodynamical formula is unavoidable, the following developments are offered in such a form that ordinary mathematical knowledge will render their perusal easy.

COMPOUND AIR COMPRESSORS.

As stated in what precedes, the most successful way of increasing the efficiency of air compressors is by compounding the cylinders, or by a distribution of the total work required in compression between several distinct cylinders.

The principle of compound compression can be described as follows: Suppose that a certain volume of air at a temperature T_0 is to be raised from a pressure P_0 to a pressure P, P_0 being most commonly the atmospheric pressure of 14.7 absolute pounds per square inch.

In ordinary or single-stage compressors the free air is introduced and compressed in one cylinder, and then delivered directly into a receiver. In the compound machine this air is compressed in a first cylinder from its initial pressure P_0 to a certain pressure P_1, smaller than the terminal pressure P; there will be a certain amount of heat generated by this compression, less, however, than in a single cylinder machine.

The air at pressure P is forced from the first cylinder into a refrigerator, wherein, without losing its pressure, it is cooled down to its primitive temperature T_0, its volume being reduced accordingly. It then enters a second cylinder, where it is compressed from P_1 to another pressure, P_2, still smaller than P, then cooled down again to T_0, and so on compressed by successive stages until the final pressure P is reached, and the air delivered from the last cylinder into the receiver.

Compound air compressors thus consist of any number n of cylinders, whose size is gradually decreasing, with $(n - 1)$ coolers interposed between them, the air being always cooled down to its primitive temperature before passing from one cylinder to the next. The diagram (fig. 1) represents this series of successive compressions and of intermediate coolings.

The result of this combination is that the total heat of compression to be got rid of is divided into several fractions, the series of cylinders presenting to the cooling water, destined to absorb this heat, a greater surface than would a single cylinder, and the air being always cold when entering any cylinder in the series.

There is not, at a first glance, any special rule governing the size of the successive cylinders, and consequently the values of the intermediate pressures, and these quantities might be chosen at random, but when adding the partial amounts of heat generated in the successive cylinders, their sum, which represents the total heat of compression, and consequently the total work, would not, of course, be the same, whatever might be the sizes of the cylinders, and since accepting the complication due to their larger number, it is expedient to know whether certain particular sizes and intermediate pressures do not give a minimum value for the total work of compression.

Compounding has so far been done with two successive cylinders, and one intercooler for usual air pressures; however, three cylinders are employed for high pressures, and the principle of compound compression being independent of the number of cylinders, the question will first be solved generally.

Calling:

J the Joule's equivalent = 772.

W the weight of air introduced in the first cylinder.

C the specific heat of air at constant pressure = 0.2377.

T_0, T_1, T_2 . . . . . T_n the absolute temperatures corresponding respectively to the absolute pressures.

P_0, P_1, P_2 . . . . . P the absolute initial pressure in each respective cylinder, the total adiabatic work (compression and delivery) effected in the first cylinder will be:

$$J\,W\,C\,(T_1 - T_0) = J\,W\,C\,T_0\left(\frac{T_1}{T_0} - 1\right)$$

The total work in the second cylinder will be:

$$J\,W\,C\,T_0\left(\frac{T_2}{T_0} - 1\right)$$

in the third cylinder:

$$J\,W\,C\,T_0\left(\frac{T_2}{T_0}-1\right)$$

and in the nth or last cylinder :

$$J\,W\,C\,T_0\left(\frac{T_n}{T_0}-1\right)$$

Since the initial temperature T_0 is the same in all cylinders, as $J\,W\,C$ are constant quantities, and as T_0, being the temperature of the atmosphere, can also be considered as constant at a given place and time, the minimum amount of work will be developed when the sum of the partial work is a minimum, or when

$$(T_1 + T_2 + T_3 + \ldots\ldots + T_n)$$

is a minimum.

Now 1.4 being the ratio of the specific heats of air at constant pressure and at constant volume, we know that in adiabatic compression the ratio of the final to the initial absolute temperature is equal to the ratio of the final to the initial pressure, raised to the power $^{0.286}$. Writing this relation for every one of the (n) cylinders of a compound compressor, and multiplying respectively the first and second members of these (n) equations, we find that the product of the terminal temperatures depends solely upon the initial temperature, the atmospheric pressure and the receiver pressure—*i.e.*, that this product is constant in each particular case.

But the sum of a number of variable and positive factors, whose product is constant, becomes a minimum when these factors are equal ; the total work of a compound compressor will therefore be as small as possible when the initial and final temperatures are the same in all the cylinders, or, in other words, when the total work is equally divided among all the cylinders, whatever be their number. As before stated, the two-cylinder compound is by far the most commonly used, and it shall be dealt with more particularly.

Without developing the details of the calculations, it shall be stated that in this compressor, which has one intercooler, the first cylinder, into which the compression begins, is called the low-pressure cylinder, and the second cylinder, wherein the compression is completed, is termed the high-pressure cylinder.

The intercooler pressure must be a mean proportional between the atmospheric and the receiver pressures—*i.e.*, if P_1 designates the absolute intercooler pressure, P_0 and P the atmospheric and receiver pressures, we must have :

$$P_1 = \sqrt{P\,P_0}.$$

The volume V_0 of the L. P. cylinder and the volume V_1 of the H. P. cylinder, in which the initial temperature is the same, are connected by the isothermal relation :

$$V_1 = V_0\sqrt{\frac{P_0}{P}}.$$

If the stroke of both these cylinders is the same, which is generally but not necessarily the case, the equal repartition of the total work between them leads to conclude that at any point of the stroke the loads on both pistons are equal ; and if we compare the terminal load on the piston of an ordinary compressor to the aggregate terminal load of a tandem compound machine raising the air to the same receiver pressure, the ratio of the former to the latter will be found equal to :

$$\sqrt{\frac{P}{4\,P_0}}+\frac{1}{2},$$

P and P_0 being, as above, the absolute receiver and atmospheric pressures, if $P = P_0$—*i.e.*, if there is no compression at all, this formula becomes equal to 1.

Comparing now the work developed in a single cylinder and in an equivalent compound set, we shall find that when the ratio of the receiver pressure to the atmosphere is :

5 6 7 8 9

and if the work developed in the compound is 1, the adiabatic work with no cooling in the single cylinder is respectively :

1.131 1.147 1.16 1.175 1.185,

showing a gain in favor of the compound of :

11.5% 12.8% 13.8% 14.9% 15.9%,

which increases, therefore, with the receiver pressure.

If the cooling during compression is as perfect as practicable —*i.e.*, if the compression curve is $p\,v^{1.2}$ = constant, the work of the compound being 1, the work of the single cylinder is respectively for the above receiver pressures :

1.069 1.081 1.089 1.095 1.102,

showing a gain in favor of the compound compressor of

6.4% 7.5% 8.2% 8.7% 9.2%.

When the cylinders are cooled externally by means of a jacket, which is an almost general practice in America, the percentage of work gained by the use of a compound compressor can be taken, with a convenient degree of approximation, as :

8.95% 10.2% 11% 11.8% 12.5%.

These figures show that the economy of compounding for the usual air pressures ranges from 10 to 12 per cent., by no means a neglectable quantity, especially for compressors of great power.

It may be here noticed that the preceding results were based upon the assumption that no variation of pressure occurred between the two cylinders ; in practice the capacity of the intercooler has some influence upon the intermediate pressures, comparable, to some extent, to the "drop" that takes place in the receiver of a compound steam engine.

The relative connections of the pistons—*i.e.*, either tandem set or quartering, also affects these variations of pressure, whose effect is to impair the equal repartition of the total work between the cylinders.

These points, whose close investigation would belong to a didactic treatise on the construction of air compressors, can only be mentioned here.

It will be found that the gain increases with the number of stages adopted for the compression ; but it should also be borne in mind that the various resistances increase with the number of cylinders, to say nothing of the cost of purchase and maintenance ; discrimination must therefore be used in combining these conflicting elements, and it is hardly probable that the use of a triple compound machine would be advisable as long as the terminal pressure does not reach 9 atmospheres absolute, and even then unless the compressor be of considerable power. But as a rule, and in all cases, it appears that the single-stage compressor absorbs more work than the compound to produce a given amount of air at a given pressure.

Summing up the above conclusions, we see that compounding increases the efficiency of a compressor on two distinct grounds : In the first place, the heat generated during the process of compression is thus more readily absorbed, because the aggregate cooling area is larger in the compound, whose L. P. cylinder is always the same as the cylinder of the single-stage compressor of the same capacity and piston velocity, and also because the amount of heat subject to the action of this cooling area is smaller.

This, however, is not the only advantage ascribable to the compound machine ; it has also been shown that the maximum piston load was less in this latter compressor than in the former. The result thereof will be best understood in a practical illustration.

Fig. 2 represents the adiabatic cards of a 12" × 16" single-stage machine, and of a tandem compound (12" + 7¾") × 16", both compressing to 70 lbs. gauge ; it also shows the expansion curve in a 12" × 16" steam cylinder, developing with steam at 80 lbs. gauge, a work equal to that of the single-stage air cylinder.

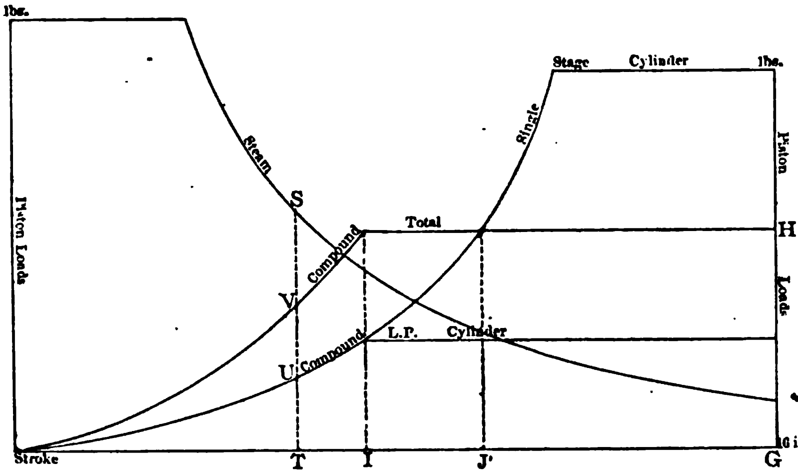
These cards, which are theoretical, do not show the variations of pressure, but the effective loads on the piston-rod, either of the single-stage air cylinder or of the tandem-compound set of air cylinders, or of the single steam cylinder, and they will serve for the comparison of two direct-acting steam compressors, one of them in the single stage and the other in the compound system.

As we know, these cards show a less aggregate piston load in compound set than in the single air cylinder, and as the initial loads are the same range of variation is less in the compound, hence already a reduction in the size of the piston-rods and also of the crank-pin and connecting-rod. But it will be noticed that the compound curve has a sharper rise, since the maximum load $H\,G$ is reached at the point I of the stroke, while in the single cylinder this same load is only reached at the point J^1.

The result of it is that during this portion of the stroke, which precedes the points of equal loads in the two compressors—that is to say, the point of intersection of the steam and air curves, the difference between the loads on the steam and air pistons is smaller in the compound, where it is $S\,V$,

than in the single-cylinder compressor, where at the same point, T of the stroke, the difference is $S\ U$.

The same may be said for the second portion of the stroke, except in the region $I\ J^1$, but here the discrepancy is unimportant, the piston loads being but little at variance in the two compressors, and this region corresponding precisely to the maximum velocity of the pistons. As the mass of moving pieces, whose momentum is resorted to for securing a regular motion, is a direct function of the actual difference between the loads on the steam and air pistons, we see that lighter pieces will be required in the compound than in the single compressor.



It might be observed that the work absorbed in compression being less in the compound, a smaller steam cylinder should be used ; actual practice shows, however, that the same size of steam cylinder is adopted for a given dimension of the L. P. compound or of the single air cylinder, the point of cut-off being, of course, variable.

A longer expansion of steam, combined with a less weight of machinery, concur in winning for the compound compressor the deserved claim of being a better balanced and more economical machine that the single-stage compressor.

The determination of the size of the intercooler in various cases, the influence of the valve areas and of the arrangement of the cylinders upon its proportions, the computation of the amount of cooling water, and a study of the positive valve motion, are as many subjects of practical interest which should be dealt with in a complete investigation of the compound compression, but whose treatment would extend the size of this paper beyond reasonable limits.

The above developments will, it is hoped, suffice to show that the economical production and utilization of compressed air are governed by very precise rules, and favored by such an array of practical advantages that its extensive use as a means of transmitting motive power seems to present itself foremost among the prospects of a near future.—*Industry.*

MARINE NOTES.

Draining of the Zuyder Zee.—The royal commission of Holland, which has for a long time been engaged in draining the Zuyder Zee, has just completed its work. Twenty-one members out of 26 approve of the project. The surface to be drained is about 72,782 acres, whose value is placed at $130,000,000. The total expense is placed at $106,000,000, which includes the expense of works for protection and the payment of indemnities to fishermen in the Zuyder Zee. The drainage will be accomplished after the construction of a dike uniting Holland with the western point of Friesland. The commission is unanimous in recommending the execution of this work to the Government.

The "Priscilla."—The new Fall River steamer *Priscilla* is now in commission, and making regular trips between New York and Fall River. The vessel is one of the finest running out of New York Harbor. It was built under the personal supervision of Mr. G. Pierce, Supervisor of the Old Colony Railroad Company. Her hull is constructed of steel, with a double bottom, having 56 water-tight compartments. Besides which the hull is divided above the inner bottom and at the ends of the vessel by means of bulkheads extending to the main deck, and by flats into 6 additional water-tight compartments, making 62 in all. The main engine is a double-inclined compound surface-condensing type of 8,500 maximum H.P. There are two high-pressure cylinders each 51 in. in diameter, side by side forward of the main shaft, and two low-pressure cylinders each 95 in. in diameter side by side aft of the main shaft, all having a stroke of 11 ft. The vessel is equipped throughout with Blake pumps. The paddle-wheels are of the feathering type, 35 ft. in diameter outside of the buckets. There are 13 curved steel buckets in each wheel, each bucket being 5 ft. deep by 14 ft. wide. The main boilers are 10 in number, of the single-ended Scotch type, and were built for a maximum steam pressure of 150 lbs. There are five decks—main, saloon, gallery, break and dome—on which are located 361 state-rooms for passengers and 35 officers' rooms, making a total of 396 state-rooms. The style of decoration throughout the greater part of the steamer is that of pure Italian Renaissance. The quarter-deck is very spacious, with a floor laid in marble mosaics. From the quarter-deck the grand staircase leads to the main saloon. It is made of solid mahogany, with strings of railing of wrought iron. Here are the ticket office, barber shop, coat-room and entrance to the dining-room lobby. The walls of the quarter-deck are finished with mahogany and ornaments and panels of papier maché, representing by groups of figures in low relief commerce, arts and sciences. The cost of the vessel was $1,500,000. She is licensed to carry 1,500 passengers. The following are some of the principal dimensions of the vessel :

Length over all	440 ft. 0 in.
Length on water-line	424 ft. 0 in.
Beam on water-line	52 ft. 6 in.
Width over guards	93 ft. 0 in.
Depth	20 ft. 6 in.
Draft, loaded	13 ft. 0 in.
Displacement tonnage, loaded	5,200 tons
Engines, type	Double inclined compound
Engines, H.P	8,500
Cylinders, 2 H. P	4 ft. 3 in. × 11 ft.
Cylinders, 2 L. P	7 ft. 11 in. × 11 ft.
Paddle-wheels, diameter	35 ft.
Boilers, type	Scotch or marine
Boilers, number, 10 H. P	8,500
Grate area	850 sq. ft.
Heating surface	34,700 sq. ft.
Speed	22 miles per hour

The "Minneapolis."—The cruiser *Minneapolis*, which was illustrated and described in THE AMERICAN ENGINEER AND RAILROAD JOURNAL for September, 1893, has recently had her preliminary trial off the Delaware capes, and her official trial off the coast of Massachusetts. In the first on the offshore run a speed of 21.75 knots was made. The boilers were worked under a forced draft, with anthracite coal burning in the furnaces. From the time of leaving the yards the three engines were run continuously while the cruiser was steaming, and not a flaw of any kind showed itself in her machinery. The *Columbia*, on her preliminary trial trip, showed 20.98 knots, so that the *Minneapolis* showed fully ¾ of a knot greater speed. Rough calculations from the indicator cards showed a development of 20,800 H.P., or nearly 3,000 H.P. more than those of the *Columbia* on her official trial trip. On the official trip which was made off the coast of Massachusetts, the engines developed the full 21,000 indicated H.P. called for in the specifications, and developed a speed of 23.05 knots an hour over a course 84 knots in length. The Government boats marking the course were the *Iwana, New York, Fern, Fortune, Atlanta, Leyden, Vesuvius* and *Dolphin*. The time taken at the different stake boats going north was as follows : 22.74 knots, 22.23 knots, 22.75 knots, 22.09 knots, 21.09 knots, 24.05 knots. After a detour of 12 miles made without slowing the engines, the time on the southern trip was as follows : First station, 25.20 knots, 22.40 knots, 24.40 knots, 21.80 knots, 22.86 knots, 22.07 knots, 23.22 knots. The average speed, therefore, on the northern run was 22.90 knots, and on the southern, 23.20 knots, while the average for the entire run of 87.94 knots was 23.05 knots. According to the unofficial reports, the engines developed 21,000 H.P. while running from 130 to 136 revolutions per minute, with an average for the entire course of 134. If the official reports agree with the un-

official figures of the Board, a bonus of $402,500 over and above the contract price will be paid to the builders.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.

SECOND SERIES.—CHEMICAL METHODS.

IX.—METHOD OF DETERMINING TIN IN PHOSPHOR BRONZE.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(*Continued from page* 321.)

OPERATION.

Dissolve 1 gram of fine borings in 20 c.c. of C. P. nitric acid, 1.20 specific gravity, and evaporate at a temperature not exceeding 225° F., until the residue will not adhere to a dry glass rod. Add 15 c.c. of concentrated C. P. nitric acid, 1.42 specific gravity, heat where the temperature is about 275° F. for 10 minutes, add 30 c.c. of distilled water, stir thoroughly, allow to settle a little, and then filter, washing with distilled water, until a drop of the filtrate evaporated on a piece of clean platinum foil leaves no residue. Set the filtrate aside to be used later in the determination of the lead and copper. Put the filter with the hydrated metastannic acid on it back into the same beaker, taking care to spread out the filter, and add 150 c.c of yellow ammonium sulphide. Digest with a cover on the beaker at a temperature of about 212° F. for a couple of hours, with occasional stirring. Nearly all, and in some cases all, the tin dissolves as sulphide, the phosphoric acid goes into solution, while most of the copper, iron, lead, etc., which may be present, remains as sulphides suspended in the liquid. Filter into a beaker holding about 25 fluid ounces, and wash with dilute sulphide of ammonium wash water, and at last with water alone, until the volume of the filtrate and washings amounts to about 250 c.c. Dilute the filtrate and washings with distilled water until the volume is about 400 c.c., and then precipitate the tin sulphide with concentrated C. P. hydrochloric acid, adding it cautiously with stirring, and only adding sufficiently slight excess to react clearly with litmus paper. Cover the beaker and put it where the temperature is about 100° F., and allow to stand one night. Dissolve the sulphides in the filter in dilute nitric acid, and wash thoroughly with water. Add the filtrate to the beaker containing the copper and lead salts. Burn off the filter, ignite at a high temperature in porcelain crucible, weigh and add the weight to the binoxide of tin obtained from the precipitated sulphide. After standing over night, decant the clear liquid above the sulphide of tin through a filter, taking care to get as little as possible of the precipitate on the filter; then add about 150 c.c. of water to the beaker, stir thoroughly, and allow to settle clear. Decant the clear liquid through the same filter, and then add about 150 c.c. of acetate of ammonia water, stir thoroughly, and allow to settle clear and decant as before. Repeat this last operation twice more, provided the second addition of acetate of ammonia wash water settles off clear at once; then pour the precipitate on the filter and wash with the acetate of ammonia wash water until the washings no longer react with nitrate of silver solution. If, after the second addition of acetate of ammonia wash water, the precipitate settles a little slowly, and there is a tendency to a turbid liquid above the precipitate, omit the third addition of acetate of ammonia wash water, and proceed to pour the precipitate on the filter, and finish the washing on the filter as above described. Put the filter and precipitate, still wet, into a porcelain crucible, "smoke off" the filter very slowly, and continue the heating over the burner at low temperature, after the filter has disappeared, until the odor of sulphurous acid is no longer perceptible. Gradually raise the temperature with the burner, finish with an intense heat, and then weigh.

APPARATUS AND REAGENTS.

The apparatus required by this method is simply the ordinary beakers, measuring glasses, etc., common to every laboratory, and requires no special comment.

The nitric acid 1.20 specific gravity is made from the stronger by dilution with water. The dilute nitric acid used to dissolve the sulphides on the filter is a mixture of one part concentrated C. P. with four parts of distilled water.

The yellow ammonium sulphide is made by dissolving 1 oz. of precipitated sulphur in a 5-lb. bottle of what is known in the market as ammonium hydrosulphide, or hydrosulphuret.

The ammonium sulphide wash water is made by adding one part by volume of commercial C. P. ammonium hydrosulphide to nine parts by volume of water.

The acetate of ammonium wash water is made by nearly neutralizing concentrated C. P. acetic acid 1.04 specific gravity with concentrated C. P. ammonia 0.90 specific gravity, and then adding one part by volume of this solution to three parts by volume of distilled water.

CALCULATIONS.

Atomic weights used: Tin, 118; oxygen, 16; molecular formula, SnO_2. Since 78.67 per cent. of the binoxide is metallic tin, the weight found expressed in grams, multiplied by this figure, gives the amount of metallic tin in 1 gram of the bronze. Then the amount in 100 grams, or the per cent., would be found by multiplying this figure by 100. This may be briefly expressed by the rule: Express the weight of binoxide found in grams, move the decimal point two places to the right, and multiply by 0.7867. The product will be the per cent. of tin in the bronze. Thus, if the weight found is 0.1284 gram, the percentage will be [12.84 × 0.7867] 10.10 per cent.

NOTES AND PRECAUTIONS.

It will be observed that this method oxidizes the tin and separates it from the principal portion of the lead, copper, iron, etc., by nitric acid, finishes the separation as completely as ammonium sulphide will do, and removes the phosphoric acid by dissolving the separated metastannic acid in yellow ammonium sulphide, precipitates the tin as sulphide along with much separated sulphur, and converts this sulphide into binoxide for weighing by careful ignition.

The evaporation to dryness needs to be managed with some care. If the temperature is too high, and especially if the action of the heat at high temperature is too prolonged, there will be difficulty with the subsequent solution in ammonium sulphide. On the other hand, if the evaporation to dryness is not carried far enough, the separated metastannic acid is apt to be slimy and give difficulty in the subsequent filtration. A little experience will enable the right point to be reached without difficulty. The treatment of the separated metastannic acid with hydrochloric acid either with or without the addition of potassium chloride to assist the subsequent solution in ammonium sulphide is not necessary if the evaporation to dryness is properly managed, and this procedure introduces complications in the analysis which are better left out.

Fifteen c.c. of concentrated C. P. nitric acid are added to take up the copper and lead salts, after the evaporation to dryness, because approximately this amount of nitric acid is needed in the solution during the subsequent determinations of the lead and copper by electrolysis.

We have not succeeded by any manipulation in completely separating copper and iron from metastannic acid by means of nitric acid, and do not, therefore, recommend ignition and weighing the precipitate obtained after taking up the copper, lead, etc., in strong nitric acid, dilution and filtration.

The digestion of the separated metastannic acid with yellow ammonium sulphide with many bronzes takes up all the tin, so that there is almost nothing left to weigh after dissolving the other sulphides on the filter and ignition of the filter. On the other hand, with some bronzes there is apparently always a little tin left undissolved by the ammonium sulphide. Repeated experiments on a bronze showing this peculiarity gave practically the same results each time, so that it is hardly safe to neglect to follow the directions on this point. The weight of this undissolved tin is rarely more than a milligram.

It is well known that sulphide of copper is slightly soluble in yellow sulphide of ammonium. The sulphide of tin obtained is, therefore, apt to be contaminated slightly with sulphide of copper, and the final weight may also be slightly high on account of oxide of copper.

It is not advisable to leave any of the ammonium sulphide wash water in the filter when washing the sulphides of copper, lead, iron, etc., since this would introduce a little H_2S into the solution in which the copper and lead are to be subsequently determined, an addition which is not desirable. On the other hand, it is not desirable to try to wash copper sulphide from the first with pure water for fear of oxidation and loss.

The precipitation of the tin sulphide is a moderately delicate operation. There must be a slight excess of hydrochloric acid, or tin will remain in solution. On the other hand, if there is too much hydrochloric acid, there is danger of its dis-

solving some of the tin sulphide. Furthermore, the litmus paper test is apt to be affected by the H_2S set free. The litmus paper should not be put into the solution and allowed to remain during the neutralization, as it becomes completely discolored by so doing. Test with a fresh piece each time. After some experience is gained, the way the solution settles off after the last addition of acid is a very good indication of the right point. If the precipitate separates slowly, and the liquid above is inclined to be turbid, either too much or too little acid may be present. If too little, a drop or two more may be just right. If too much, add a few drops of ammonia to alkaline reaction and start again. It is advisable to always test the filtrate from the tin sulphide by adding a few drops of hydrochloric acid, if it is not already clearly acid to test paper, and passing H_2S for half an hour; then allowing the liquid to stand for a couple of hours at a temperature of 120° to 130° F. If no precipitate separates at the end of this time, the filtrate may be thrown away. If any precipitate shows, allow to stand over night, collect on a filter, wash thoroughly, ignite and weigh, adding the weight to the amount previously found.

Allowing the precipitated sulphide to stand in a warm place over night may be unnecessarily long, but as all the constituents of a phosphor-bronze are usually determined, allowing the tin to stand over night does not usually cause any delay. It seems to be essential to have the H_2S pass off before filtration, since the precipitate is sparingly soluble in solution of sulphuretted hydrogen.

In washing the tin sulphide, it is essential to remove the ammonium chloride completely, or loss of tin will follow during the ignition. By the method of washing recommended, less than 5 per cent. of the total amount of ammonium chloride present remains with the precipitate when it is put on the filter.

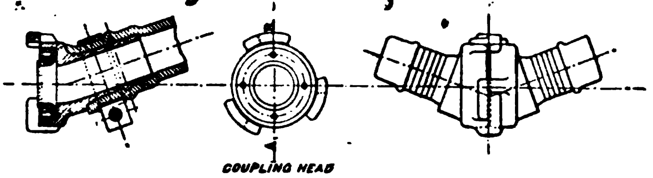


Fig. 1.

It is very difficult to wash tin sulphide mixed with separated sulphur with pure water, on account of the tendency to form a turbid filtrate. As is well known, a slightly acid solution of acetate of ammonia prevents this difficulty. It is advisable, at the very last, to use a much weaker solution of ammonium acetate, so as not to leave too much of this salt with the tin sulphide for fear of reducing some of the tin oxide during the ignition.

The ignition of the wet tin sulphide must be managed with a good deal of caution or there will be either loss of tin sulphide, free sulphur, or sulphuric acid left behind, or some of the oxide of tin reduced. It is believed all these difficulties can be obviated if the ignition is done slowly enough with free access of air. The filter is gotten rid of by "smoking off," which consists in applying the heat to the wet material in the crucible so slowly that the volatile matter of the filter passes off without ignition, free access of air being maintained at the same time. To accomplish this, fold up the wet filter with the tin sulphide in it and place it in the crucible. Put the crucible on the triangle as in ordinary ignitions, and leave the cover off. Then heat the open end of the crucible slowly. The filter and precipitate gradually dry, and soon the parts of the filter in contact with the crucible begin to distill off the volatile matter at low heat, even before the whole is dry. This process goes on if the flame is properly adjusted, until in a little while everything that is volatile at a low temperature has passed away, and the precipitate with a black envelope of carbonaceous matter is left. When this is the case, the temperature can be raised very slowly, the lamp moved back toward the bottom of the crucible a little, and the carbon burned off completely. Many times, when the temperature is raised, the black envelope of carbonaceous matter falls away from the precipitate and is rapidly consumed. The slow heating and free access of air must be continued until the sulphur is all gone. If the heating is done slowly enough, the precipitate is porous, the sulphur apparently all passes away at SO_2, and there is little danger of volatilizing tin sulphide or reducing the oxide.

In bronzes containing perceptible amounts of antimony the tin cannot be successfully determined by the method given above.

TRAIN HEATING WITH STEAM AND COMPRESSED AIR ON THE EASTERN RAILWAY OF FRANCE.

By M. Lancrenon.

Up to a very recent date the Eastern Railway Company, like the other French companies, has used hot water for heating its trains. Recognizing that this system is frequently insufficient and sometimes even troublesome for passengers, especially on night trains with a long run, we have considered for a long time that its simplicity and the ease with which it can be employed in almost all kinds of cars compensated to a great extent for its disadvantages, at least in our climate, and that there was no need for looking for anything else. But this position could not be indefinitely maintained.

As the movement of passengers and the number of trains increase the reheating and manipulation of the cans become more and more difficult, especially at Paris and in the numerous stations from which local trains start. On the other hand, we were compelled, by the necessities of the operating department, to put cars in service that had a communication from end to end, some of which were intended for trains having a long run, others for short-run trains where fares and tickets could be collected *en route*, as well as the double deck cars in the suburban traffic around Paris. The use of the hot-water cans became almost impossible in these different cars, so that it was necessary to get something else.

The long experience which we have had with thermosiphons did not encourage us to develop that system; the German systems were not applicable to our trains, which must be rapidly and frequently made up and broken. Furthermore, they did not keep the feet of the passengers warm—which, in France, is considered to be very necessary. With these conditions in view, we have been led to examine and experiment with a system which is made the subject of this communication.

Principle of the System.—In studying the operation of the German heating apparatus, I have been struck with the difficulty and the slowness with which the heat reaches the end of the train in general working, with a pressure high enough to ensure the efficient penetration of the steam into the heating pipes. In seeking to determine the cause of this phenomena, it occurred to me that it would be possible to obtain a more even pressure in the pipes by adding a fluid—such as air, for example—to the steam, and one which was not susceptible of being condensed. The first experiment was with a crude apparatus set up in the Villette shops, which confirmed the accuracy of my opinion to such an extent that more complete tests were made with an apparatus which was also set up in the shops, and represented a train of 24 cars of four compartments each. The actual cars were intercalated at different points of the circuit. The arrangements which were developed from this examination after several adjustments were then applied to special testing trains, and finally to trains in service. The principal effect of the air which was added to the steam appears to be the sweeping along and continual carriage of the water of the condensation, which tends to accumulate at low points in the pipes, and which might settle at the discharge openings. We have thus avoided losses due to the accumulation of water and the dangers of freezing. The gaseous current, rendered the more intense by the addition of air, by its friction on the liquid molecules causes them to slide along the walls of the pipes. We know that we can thus cause a liquid to pass through a considerable difference in level by using a pressure far less than the height to be raised; and it is upon this principle that the American steam loop is based, which causes, by means of a simple combination of pipes, the water of condensation produced in a pipe fed by a boiler to be carried back to the boiler. This phenomenon can be shown to a certain extent by causing a liquid to move over any surface whatever by simply blowing above it.

Thanks to the addition of the air, the examination of the best methods to be adopted for heating apparatus was singularly simplified and facilitated. It was possible to obtain a discharge of the water of condensation at each car without fear of freezing at the opening; at the same time we thus did away with an obstacle to the introduction of steam into the heating pipes, and reduced the water of condensation to a minimum, as well as compelling it to follow the general conduit to its end. It was thus possible to use heating pipes in these cars that were very much smaller and of a greater variety of forms, without limiting ourselves to maintaining the inclination which would be necessary to the flow of water that depended on gravity alone. It was also possible, in order to facilitate the regulating, to multiply the pipes, and at the same time control

them by simple admission cocks, and bring them together at their extremity at a discharge apparatus without using any arrangements whatever for preventing the return of steam into the pipes which are not in service, the air which is confined in these pipes being sufficient to prevent all heating. From a heating standpoint, the mixture gives practically the same effect as steam when used alone at the same pressure. The quantity of air added and the differences of temperature which resulted therefrom, when taken within the limits employed, are not of such a nature as to modify the calorific effects which are obtained in any appreciable manner.

Description of the Apparatus.—These preliminary matters having been settled, it was easy to settle upon the general details of our apparatus. They comprised a general conduit starting from the engine, into which the engineer could discharge his mixture of air and steam. This conduit extended throughout the whole length of the train and ended in an automatic expansion outlet, which allowed the condensation water and cool air to escape, but stopped the steam. In each car a sufficient number of heating pipes were led off from the general conduit and carried into the compartments, whence they were brought together at their ends and let into a common outlet. The admission cocks let steam into one or all of these pipes at will.

General Conduit and Couplings.—The dimensions of the general conduit were determined after numerous trials, and were made of such a size as to permit of an easy heating of trains of from 15 to 18 cars, and occasionally of 24. Recognizing that it was to our advantage to reduce the diameter at the couplings, we thus obtained the twofold advantage of having the couplings more easily handled, more durable, and of increasing the velocity of the current, so as to avoid as far as possible the accumulation of water and the losses in pressure which would result therefrom. Our conduits, therefore, have an outside diameter of 1¾ in. except at the couplings, where this diameter is reduced to 1⅜ in. The coupling hose is made of rubber, and is fastened to the cars just as the air-brake hose is fastened. The couplings are made by means of flush prongs which clip into each other by a bayonet movement, and which are so designed as to avoid any sudden sagging in the conduit. This design is one for pipes where, as I have already said, a double accumulation of gas and liquid is circulated, the latter sliding along the walls under the entraining action of the current of gases. We have absolutely discarded the German coupling, which was formed of hose independent of the cars, and which is the cause of a great number of inconveniences in the service.

Apparatus on the Engines.—Two arrangements were adopted for the engines. On powerful engines intended for hauling long trains a single pump was found to be insufficient for the brake and the heating service. We have therefore placed a second pump thereon, which was especially intended for the heating, and which discharges into the general conduit both the compressed air and the steam which has served to compress it.

The steam from the boiler thus serves by its expansion to compress the air, and is then utilized for the heating. The speed of the pump in running and its discharge are regulated by means of a steam admission valve. A throttle valve placed directly on the boiler, a safety valve and a steam gauge complete the apparatus on the engine.

On engines which are intended for hauling light trains that consist of not more than 8 or 10 cars, the special heating pump is done away with, and the heating apparatus consists simply of a throttle valve directly on the boiler, an air cock on the pipe opening into a discharge pipe of the air pump for the brake, a safety valve and a steam gauge. In both types the safety valves are set at 17 lbs. per square inch.

Apparatus on the Cars.—The first thing we looked to in the cars was to see that the feet of the passengers should be heated, and then to avoid all contact between the air of the compartments and the pipes directly heated by the steam, so as to prevent the liberation of all odors. In second and third-class cars (fig. 2) the heating pipes, which were three in number, branched out from the general conduit at one end of the car. They first rise vertically to enter into the body of the car, going through the double floor, and then turn horizontally over the top of the floor, passing successively into each compartment under the feet of the passengers. They are covered with ribbed sheets, which are thus heated, and which in turn heat the car.

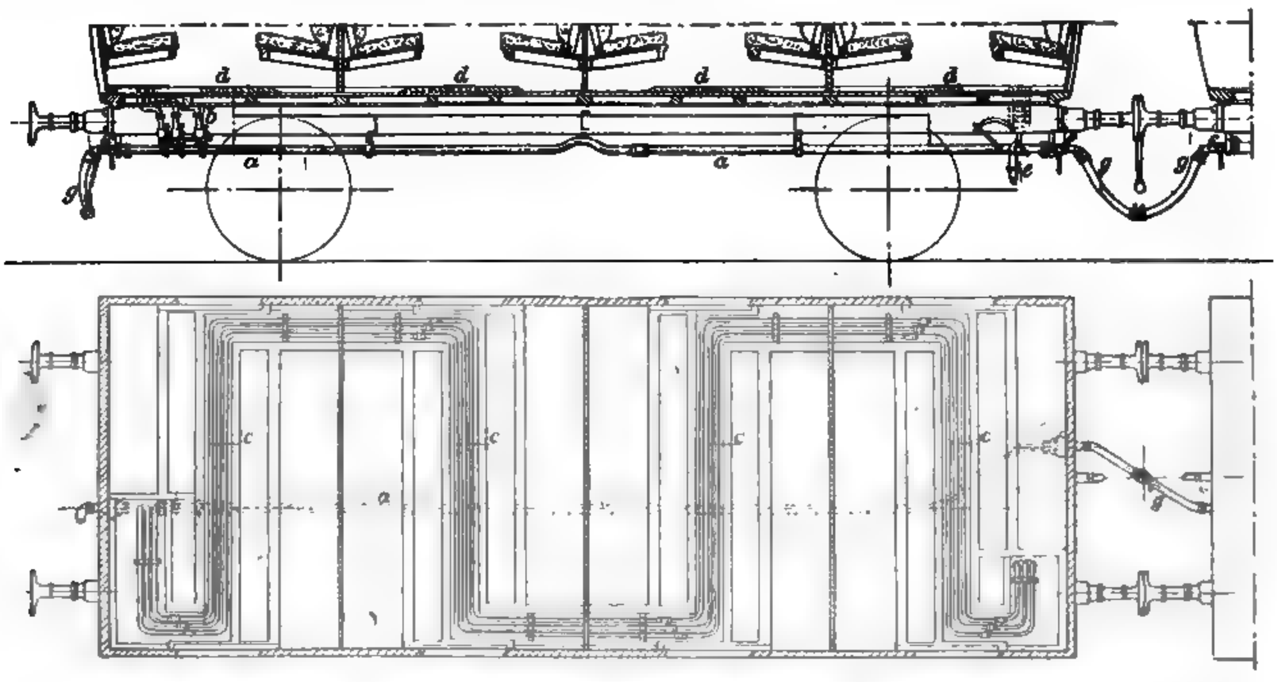


Fig. 2.

In order to avoid too close contact and too great an elevation of temperature of these heating sheets, air spaces with a thickness of .04 in. are left between the pipes and the sheets. The three pipes are carefully isolated throughout their whole passage through the compartments. On leaving the last compartment they are united in order to enter the automatic outlet. The admission pipes can be operated from the outside by means of wrenches, and thus the mixture of air and steam be admitted at will into one, two or three pipes. In this way the heating is regulated. This regulation is also necessary for each compartment of the same car, and the attendants alone can control it from the station platforms.

In first-class cars (fig. 3) it was considered necessary to make the heat independent for each compartment, and to place the regulation at the disposition of the passengers. The arrangement adopted is slightly different from that described. There are two heating pipes for each compartment; they branch out from the general conduit at the right end of the compartment, enter it, pass beneath the feet of the passengers, leave the body to enter a common collector which ends in an automatic outlet. The admission cocks can be controlled from the inside by the passengers or from the outside by the employées. The covering sheet is of brass, and, thanks to its greater conductibility, it gives out the same amount of heat with two pipes as

iron sheets do with three. There is, however, one less degree of regulation possible than in the other cars, but this inferiority is compensated for by placing the regulation at the disposition of the passengers.

The third arrangement, which is entirely different, was adopted for our double-decked cars that are run on the short transit trains in the suburban service of Paris, and is shown in fig. 4. The general conduit of each car is forked, and passes out of the upper story along the side walls. It thus serves as a heating pipe, and heats the wall of this upper story. It is to the others, but is well adapted to the rolling stock to which it is applied. It is not possible to improve it without involving complications and difficulties which are out of all proportions to the object which is sought to be obtained.

Automatic Outlet.—I have only one word to add descriptive of the automatic outlet, which can be placed at the end of the general conduit and on each car. The problem to be solved was to find an apparatus which would only allow the water of condensation in the pipes and the corresponding air to escape, and then close itself as soon as the steam came into contact

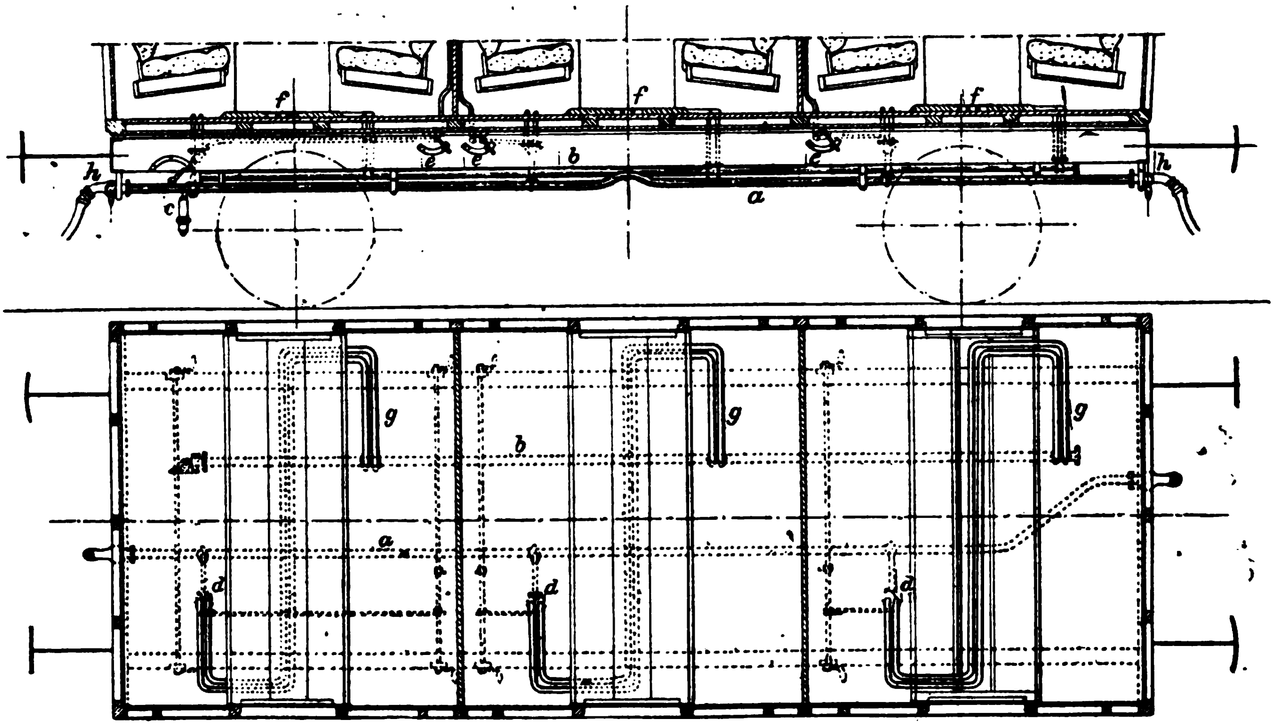


Fig. 3.

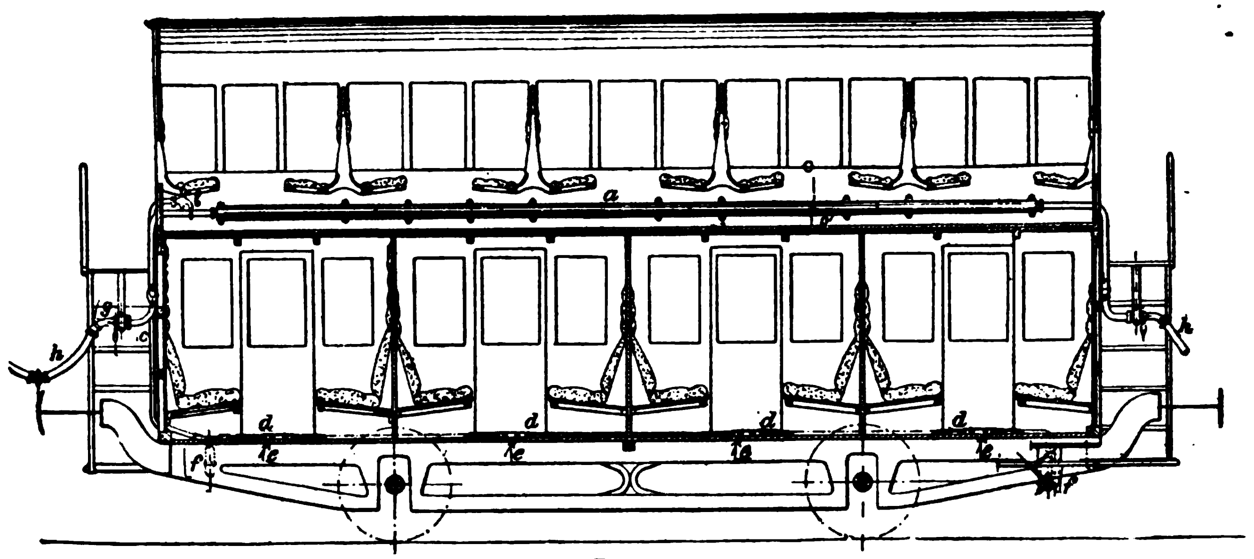
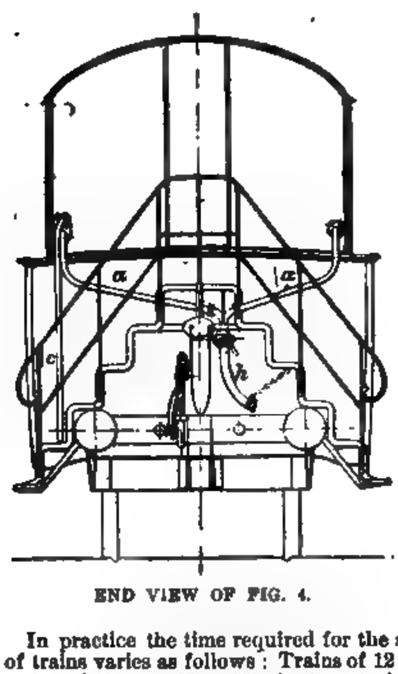


Fig. 4.

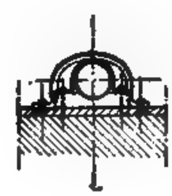
protected by a covering sheet to avoid all danger of burning. A pipe which is controlled at its inlet by a simple stop cock, and which is never closed except in case of breakage, branches off from the general conduit in the upper story and descends to the lower story, where it is divided into two pipes running side by side over the floor and passing successively through all the compartments beneath the feet of the passengers, being finally united again to enter an outlet. No regulation is possible except for the whole of the train, and that is under the control of the engineer, who keeps the heat turned on continually or at intervals; this arrangement is evidently very inferior with it, perfectly regardless of the pressure in the pipes. Such a result can only be obtained by means of an apparatus working by the expansion of a liquid that would give off no vapors at the temperatures under which it worked. The expansions of solids are too slight, and, if they were used, only very slight openings could be obtained, while it might be checked by a single drop of frozen water. With gases and liquids giving off a vapor we would have an apparatus influenced not only by the temperature, but also by the pressure; the liquid must therefore be neutral and unalterable; we have therefore selected oleonaphtha. This liquid is enclosed in a tight metallic cas-

ing that ends in a metallic bellows in the form of a Venetian lantern, which elongates when the liquid expands. The casing is enclosed in another, which is fastened to the ends of the discharge pipes. When steam reaches this envelope the liquid expands, the bellows elongates and closes the opening placed at the end of the same. When, on the other hand, the envelope simply contains air or water, the bellows opens the valve, which then allows this air and water to escape. This apparatus, after frequent attempts and some fruitless trials at the beginning, now works regularly and without danger of freezing even at a temperature as low as from zero to 5° above on the Fahrenheit scale, thanks to the use of compressed air.

Advantages and Disadvantages of the System.—The apparatus I have thus described was put into service during the winter of 1891-92 on the trains running in the suburban service of Paris. The following winter three trains heated in this way were put into service; finally, during this past winter, this system has been put into service on seven trains doing the greater part of the suburban service of Paris on the Avricourt Line, over which 48 trains were run each week day and 54 on Sunday; then on the regular line a large number of night trains, made up of new rolling stock intended for interchange traffic. The necessary apparatus has already been placed on more than 300 cars and on 142 engines. Our experience thus far with these prolonged and somewhat extended tests is such that we may say that the results obtained have always been satisfactory. Our heating sheets have a breadth of about 1 in and a length of 8 ft. 4 in. When the three heating pipes are in use their temperature rises from 140° to 158° F. We consider that this is enough when we take into consideration the dimensions of our compartments and the cold which we have to encounter. It is very evident that this could be raised either by increasing the surface of the sheets and the number of the pipes, or by heating the air of the compartments by pipes placed beneath the seats. From the standpoint of initial heating we have made considerable progress over systems of steam heating by increasing the diameter of the general conduit, and by permitting the air enclosed in the heating pipes to freely escape, and finally by entraining, by means of compressed air, the water of condensation which opposes the flow of the steam.



END VIEW OF FIG. 4.



COVERING OVER STEAM PIPES.

In practice the time required for the steam to reach the end of trains varies as follows: Trains of 12 cars, 8 to 10 minutes; trains of 15 cars, 12 to 16 minutes; trains of 18 cars, 15 to 20 minutes; trains of 24 cars, 28 to 35 minutes. It is necessary to add 5 to 10 minutes to these figures before the heating sheets of the last cars reach a temperature of 130° F. The last figures correspond to the very low outside temperature of from 5° to 15° F. above zero. We thus see that in any case half an hour is sufficient to heat a train of 18 cars.

It is thus possible, without causing any inconvenience whatever, to add one or two cold cars to the end of a train at the last moment, as a very few minutes is sufficient to heat them.

A greater rapidity of operation can be obtained by increasing the diameter of the general conduit, but then the weight of the apparatus raised greater difficulties in making the coupling; but, as a matter of fact, heavy trains are comparatively rare in the winter season, so that we have not found any disadvantages resulting from the diameter of our conduits. The possibility of regulating the heat is as complete as could be desired, for we can not only vary the number of pipes in use, but also interrupt the heating and resume it at will. A very conclusive experiment was made in this in our suburban service during the last winter. At that time the weather remained fine for a long time, but with great variations of temperature. In the morning at sunrise the thermometer

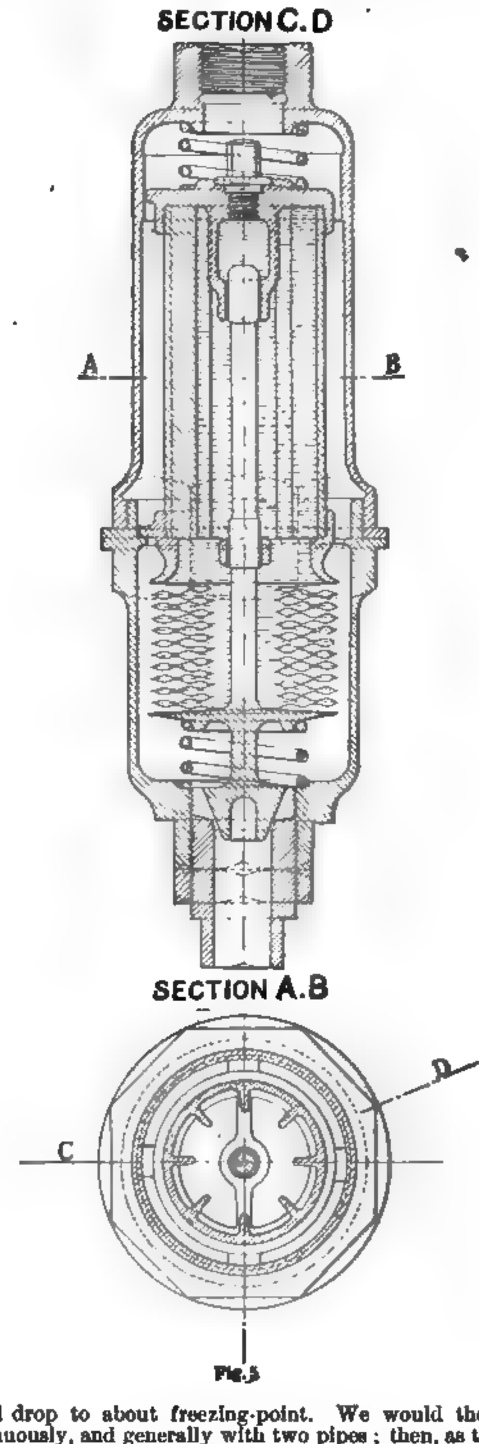


Fig.5

would drop to about freezing-point. We would then heat continuously, and generally with two pipes; then, as the temperature rose, one pipe would be closed. As the thermometer still continued to rise, we would heat the sheets slightly before starting, and then, cutting off the steam, the sheets would remain warm until the end of the trip. If this lasted too long, they would be slightly heated while *en route*. In the middle of the day the heat was entirely cut off, in the evening a reverse practice was followed. In *résumé*, I may state that we can heat our cars when and where we like, and that the em-

ployés can quickly acquire the necessary skill. We have also avoided all danger of fire and all liberation of deleterious gases, as well as the generation of disagreeable odors. In order to obtain this last result it has been necessary to completely isolate the air of the compartments from pipes that are in direct contact with the steam pipes, which have an elevated temperature, and on which any dust that might fall would burn with a characteristic odor; and this is what we have done.

By the arrangement which we have adopted we have been able to comfortably heat the feet of our passengers and then to raise the temperature of our compartments to a moderate degree, and thus maintain a true hygienic condition.

The system has worked for three winters to the entire satisfaction of the operating department. We have had, especially at the beginning, a few disagreeable incidents, some of which —but these were very rare—were due to the inexperience of the employés, others to local defects of the apparatus, which are, of course, unavoidable when an entirely new system is put into service.

The weight of the apparatus averages about 1,100 lbs per car. This is evidently an increase of dead weight which must be hauled in summer as well as in winter. But it would be difficult to advise anything lighter where a fixed apparatus is used.

The first cost is about $300 per engine for our suburban motive power, which is intended to haul trains of greater or less weight; about $80 for engines intended to haul light trains; from $160 to $180 for second and third-class cars, according to the number of compartments.

The advantages which this system has shown are of such a nature that the Eastern Railway Company has not hesitated to extend its applications to other suburban services in order to increase the comfort of passengers and do away with the trouble arising from the use of hot-water cans.—*Bulletin of International Railway Congress.*

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

The object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publication will in time indicate some of the causes of accidents of this kind, and to help lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with information which will help make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a great favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in June, has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS IN JUNE.

Pittston, Pa., June 1.—Ira Gerhardt, an engineer on the Baltimore, Lackawanna & Western Railroad, while leaning out of his cab window, was struck by a post alongside the track at Nay Aug. He was so badly injured that he died shortly afterward.

Miamisburg, O., June 1.—Engineer William Morgan, on the Pittsburgh & Erie Railway, was seriously injured in a head-end collision between a freight and passenger train near here to-day.

Alton, Ill., June 4.—A work train ran into a string of cars three miles east of here to-day, on the St. Louis, Chicago & St. Paul Railway. Engineer Bernard Lynch was killed and Fireman Edward Harrison was seriously injured.

St. Louis, Mo., June 4.—The passenger train on the Mobile & Ohio Railroad was ditched at Fisher's Lake, near Columbia, to-night. The engineer and fireman are reported to be fatally injured.

Philadelphia, Pa., June 4.—Samuel Brown, a fireman on the Philadelphia & Reading Railroad, was killed while attempting to board a moving train this morning. He stumbled and lost hold of the car and fell beneath the wheels. The head was severed from the body.

Hudson, N. Y., June 5.—A wild freight train on the Central Massachusetts Railroad ran into a shifting engine in the Oakdale yard this afternoon. This started the shifter, which ran into another wild freight at Canada Mills, and Engineer Litchman had his leg broken.

Lyons, N. Y., June 5.—Engineer De Wolfe, while leaning out of his cab window, was struck by a mail-pouch catcher. He was knocked senseless, but soon recovered.

Brazil, Ind., June 6.—Engineer William Barr, hauling an extra freight train on the Vandalia Line, was hit by a large stone on the back of his head and killed almost instantly; the stone was thrown by one of a mob of miners.

Knightsville, Ind., June 6.—Strikers stopped a freight train at this point this afternoon, and killed the engineer with stones.

Duluth, Minn., June 7.—A crowd of strikers surrounded a train on the St. Paul & Duluth Railroad and stoned the engineer, injuring him seriously.

Birmingham, Ala., June 7.—A Georgia & Pacific coal train ran into a burning trestle at Patton early this morning. The engine and eight cars pitched into the ravine below. Engineer Goodman had his ankle broken and sustained internal injuries. Fireman Charles Berry was badly cut about the head.

Vancouver, B. C., June 7.—A cloud burst caused a land slide and wrecked a Raymond excursion train to-day. It is reported that both engineer and fireman were killed.

Butler, Mon., June 8.—A passenger train was derailed on the Northern Pacific Railroad just west of here to-day. Engineer Draper was fatally hurt and Fireman Lemin slightly injured.

Denver, Col., June 8.—A passenger train was wrecked in Clear Creek Cañon this morning. John Cooper, the engineer, was injured. The accident was caused by a sunken rail in the road-bed on a sharp curve, throwing part of the train into the water.

Tiffin, O., June 8.—A head-end collision occurred at Republic, on the Baltimore & Ohio Railroad, between two freight trains this morning. One engineer had his foot cut off.

Atlanta, Ga., June 9.—A head-end collision occurred between a passenger and freight train on the Georgia & Pacific Railway, at Greenville, Miss. Engineers Warwick and Dunlap were mortally injured.

Golden, Col., June 8.—A passenger train on the Colorado Central Railroad was wrecked west of this place this morning. At a soft point in the track the rail had sunk, causing a derailment. John Cooper, the engineer of the train, had his back slightly hurt.

Fort Williams, Man., June 9.—A burning bridge gave way under a Canadian & Pacific express train near this point today. Fireman Whitehead and Engineer Elms were injured.

Bellaire, O., June 9.—Miners stoned an engine, hauling a coal train, near Neff's Landing to-day. Charles Bailey, the fireman, was struck on the head and his skull was fractured. Engineer Swarts was also slightly injured.

St. Louis, Mo., June 9.—A fast train on the Vandalia Line was wrecked near Pocahontas, Ill., this morning. Something broke on the forward truck, derailing the train. Fireman S. A. Paulsen was crushed under the tender and killed.

Biddeford, Me., June 10.—A passenger train on the Boston & Maine was wrecked at the station here this morning. The engine tipped over, and Engineer Clarence H. Dodge and Fireman Charles L. Thomas were injured, but not seriously. The cause of the accident was the spreading of the rails.

Owensburg, Ky., June 12.—Train wreckers ditched a train of eight cars from a coal train on the Mississippi Valley Railroad above Central City to-night. Fireman McDowell and the engineer were injured.

Red Bluffs, Cal., June 14.—The logging train belonging to the Sierra Lumber Company jumped from a trestle this morning and plunged down the cañon. The engineer and fireman were injured, but not seriously.

Aurora, Mo., June 15.—A freight train on the Greenfield & Northern Railway was wrecked by tramps, by placing rails on the track 3 miles north of Mt. Vernon this morning. The engineer was badly burned; the fireman was terribly scalded and died in great agony.

New London, Conn., June 17.—J. R. Sperry, an engineer on the Shore Line Railroad, was struck by a switching engine to-night. He was knocked down, and the wheels cut off his left leg at the knee and the toes of his right foot.

Lafayette, Ind., June 20.—A rear-end collision occurred this evening on the main line of the Wabash Road, near this city. It is reported that the engineer and fireman of the colliding train were killed.

Caldwell, O., June 20.—A freight train on the Bellaire, Zanesville & Cincinnati Railway went through a trestle near here to-night. Fireman Allen was instantly killed and Engineer Smith seriously injured.

Knoxville, Tenn., June 20.—A locomotive on the Marietta & North Georgia Railroad exploded its boiler at Hiwassee this afternoon, instantly killing Fireman James Deverais.

Duluth, Minn., June 20.—There was a collision between two trains on the Duluth & Iron Range Railroad at Robinson Lake

LOCOMOTIVE RETURNS FOR THE MONTH OF APRIL, 1894.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage.					Av. Train.		Coal Burned per Mile.						Cost per Locomotive Mile.							Cost per Car Mile.		Cost of Coal per Ton.
			Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Passenger Cars.	Freight Cars.	Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Passenger.	Freight.	
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Atchison, Topeka & Santa Fé	850	769	....	....	...	2,007,928	2,614	....	....	....	....	....	84.39	....	...	5.04	7.48	0.21	0.15	6.63	1.42	20.88	...	...	1.69
Canadian Pacific	603	...	472,423	579,990	374,575	1,326,988	2,200	....	....	...	....	...	67.49	....	...	4.73	10.52	0.36	....	5.68	1.51	22.80	....	....	3.08
Chic., Burlington & Quincy	541	....	....	....	....	1,846,782	2,489	4.72	19.74	....	....	....	84.25	....	.	4.10	5.73	0.17	0.19	7.07	0.04	17.80	....	....	1.34
Chic., Milwaukee & St. Paul	855	...	....	....	....	2,279,251	2,665	....	...	....	..	....	71.60	....	...	4.03	6.94	0.26	...	6.94	..	18.17	....	....	2.38
Chic., Rock Island & Pacific	...	564	456,562	841,101	369,312	1,666,975	2,956	....	....	53.16	71.22	40.51	60.80	9.89	4.26	3.03	5.82	0.23	....	6.23	0.40	15.71	....	....	2.02
Chicago & Northwestern	1010	1010	774,207	1,215,204	579,193	2,508,604	2,483	....	....	....	....	....	81.67	...	....	3.68	7.37	0.29	....	6.27	0.91	18.52	....	....	1.79
Cincinnati Southern	....	....	....	....	....	..	...	....	....	...	....	....	....	....	...	...	....	....	...	....	....	....	...	....	....
Cumberland & Penn.*	23	23	5,084	31,218	....	36,302	1,578	....	....	....	....	....	84.39	....	...	5.47	4.60	0.34	....	....	1.74	12.15	...	....	..
Delaware, Lackawanna & W. Main L.	213	176	70,285	196,970	322,063	589,318	3,348	....	..	..	...	....	87.45	....	....	2.88	6.74	0.41	....	6.22	....	16.25	....	....	1.55
Morris & Essex Division	162	....	173,791	146,104	88,328	408,223	2,519	....	....	...	....	....	65.23	....	....	3.59	10.22	0.37	....	6.72	....	20.90	...	...	3.10
Flint & Père Marquette	....	....	88,767	71,051	61,149	215,967	2,769	....	....	51.29	88.88	....	67.31	....	....	3.38	6.47	1.63	....	5.18	0.88	16.06	....	....	1.78
Hannibal & St. Joseph	67	67	....	....	....	231,706	3,565	4.84	17.29	....	....	....	81.72	14.55	6.14	1.49	5.47	0.09	0.15	6.41	0.02	18.63	....	....	1.37
Kansas City, Ft. S. & Memphis	149	....	90,979	190,074	83,811	364,864	2,785	....	....	....	....	....	67.84	....	....	2.83	5.01	0.23	0.44	7.39	...	15.90	....	....	1.45
Kan. City, Mem. & Birm	42	38	33,361	50,308	11,818	95,487	2,513	....	....	...	....	...	62.28	....	....	3.36	3.55	0.24	0.26	6.99	....	14.40	....	...	1.06
Kan. City, St. Jo. & Council Bluffs	36	36	....	....	....	129,325	3,592	5.03	22.84	....	....	...	72.78	14.77	4.51	3.62	6.82	0.16	0.39	6.56	0.04	17.59	....	...	1.91
Lake Shore & Mich Southern	595	....	407,966	738,629	376,148	1,522,743	2,922	....	....	58.92	88.38	37.61	67.91	....	....	2.98	4.68	0.05	0.12	6.77	0.16	14.76	....	....	1.37
Louisville & Nashville	....	....	....	....	....	....	...	..	....	....	..	....	....	....	....	..	....	....	....	....	....	....	...	....	....
Manhattan Elevated	...	293	748,173	......	66,571	814,684	2,780	....	....	...	....	....	39.67	....	....	2.00	8.00	0.20	....	9.00	....	19.20	....	....	4.04
Mexican Central	148	128	....	....	....	421,772	....	....	....	....	....	....	68.72	....	....	5.24	12.90	0.41	0.08	4.52	....	23.15	....	....	4.08
Minn., St. Paul & Sault Ste. Marie	104	79	77,860	107,705	25,139	210,704	2,667	4.97	21.34	....	....	....	67.20	....	4.66	4.65	10.86	0.24	....	6.63	....	22.38	3.52	1.27	3.20
Missouri Pacific	....	....	....	....	....	....	...	....	....	....	....	....	....	....	....	...	....	....	....	....	....	....	...	....	....
Mobile & Ohio	107	84	75,171	152,767	52,242	280,180	3,334	....	....	....	....	....	62.87	....	....	2.49	4.53	0.20	0.63	5.72	0.96	14.53	....	....	1.43
N. O. and Northeastern	....	....	....	....	....	....	....	...	...	....	....	....	....	....	....	..	....	....	....	....	...	....	....	....	..
N. Y., Lake Erie & Western	634	382	417,758	695,312	231,094	1,344,164	3,519	4.30	24.60	91.10	134.90	82.00	102.66	21.10	5.50	4.14	7.65	0.36	2.09	7.36	1.29	22.89	....	....	1.39
N. Y., N. H. & H., Old Colony Div	....	....	462,812	196,252	219,611	878,675	....	4.00	17.50	....	....	....	66.11	...	..	3.06	9.98	0.56	....	7.25	0.76	21.56	17.00	5.40	...
N. Y., Pennsylvania & Ohio	276	152	122,551	326,585	117,270	566,406	3,726	5.30	19.70	70.60	131.50	99.90	97.66	13.20	6.70	3.49	5.51	0.80	1.99	7.02	1.17	19.48	....	..	1.00
Norfolk & Western, Gen. East. Div.†	....	....	92,158	283,313	49,307	424,778	2,622	4.81	21.08	46.20	132.80	....	....	9.60	6.30	6.40	3.75	0.28	....	....	....	10.43	....	....	....
General Western Division†	....	....	95,231	327,469	60,056	482,756	2,823	5.51	17.46	77.00	137.00	107.00	121.00	13.87	7.88	9.59	4.14	0.26	....	....	....	13.99	....	....	....
Ohio and Mississippi	....	...	....	....	....	....	....	....	....	....	....	....	....	....	....	...	....	....	....	..	....	....	....	....	....
Philadelphia & Reading	....	...	408,101	302,013	705,766	1,415,883	....	....	....	....	....	....	81.97	...	...	4.54	4.86	0.25	....	5.74	0.48	15.87	....	...	...
Southern Pacific, Pacific System	725	639	690,942	775,768	267,216	1,733,926	2,713	5.75	14.44	....	....	....	67.07	....	..	6.41	17.41	0.21	1.98	7.22	1.10	34.33	....	..	4.87
Union Pacific	865	...	484,195	850,398	323,536	1,659,129	3,114	6.16	18.25	...	...	....	98.86	13.33	7.66	10.29	10.50	0.40	....	8.45	1.83	30.97	4.68	2.25	3.36
Wabash	418	327	411,714	549,086	190,765	1,151,565	3,521	4.58	16.98	63.59	104.98	60.96	83.33	13.33	6.20	3.49	4.47	0.26	....	6.05	0.98	15.20	2.95	1.01	1.07
Wisconsin Central	149	99	124,884	183,523	48,369	306,776	3,098	....	....	....	....	....	72.27	....	....	2.75	[illegible]	0.15	....	7.05	...	17.23	...	....	2.00

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars. Empty cars which are reckoned as one loaded car are not given upon all of the official reports, from which the above table is compiled. The Union and Southern Pacific, and New York, New Haven & Hartford rate two empties as one loaded; the Kansas City, St. Joseph & Council Bluffs and Hannibal & St. Joseph Railroads rate three empties as two loaded; and the Missouri Pacific and the Wabash Railroads rate five empties as three loaded, so the average may be taken as practically two empties to one loaded

* Switching engines allowed 6 miles per hour; wood, construction and gravel trains, 10 miles per hour.

† Wages of engineers and firemen not included in cost.

last night. Engineer Oscar Norlander was injured, suffering a contusion of the spine.

Lafayette, Ind., June 21.—A collision between Wabash freight trains occurred near this point. Engineer J. G. Storze was seriously injured.

Augusta, Ga., June 21.—Train wreckers broke a lock on the switch station of an old siding near Millen this morning, and placed ties upon the track. After opening the switch, a mixed train ran into it and was wrecked. Engineer Clem Starr and Fireman Jasper Robner jumped, but were caught in the wreck. Engineer Starr had his right leg broken and thigh fractured. He was also internally injured, and there is no hope of his recovery. The fireman escaped with a sprained ankle.

Paterson, N. J., June 22.—Engineer Floyd Pollison, hauling a fast train on the New York, Susquehanna & Western Railroad, while leaning out from the tender, trying to detect some fault with his air brakes, was struck by a signal pole and severely injured, but not fatally.

Denver, Col., June 25.—John P. Finch, an engineer on the Burlington & Missouri Railroad, fell from his engine this afternoon. His skull was fractured and his face mangled beyond recognition. The engine was moving at the rate of 20 miles an hour at the time, and he was dead when his body was picked up.

Galena, Ill., June 28.—A fireman on the Chicago, Burlington & Quincy Railroad was seriously burned this morning by the bursting of a lubricator glass which allowed the oil to flow down over the boiler head. Martin's clothes, which were saturated with oil, caught fire, and he was soon enveloped in flames.

Chicago, Ill., June 28.—Herbert Van Avery, an engineer on the Chicago & Northwestern Railroad, was fatally injured by being struck by a piece of cylinder-head that blew out this morning.

Reading, Pa., June 28.—A passenger train on the Pennsylvania Railroad ran into the rear end of a freight train 2 miles north of this city this morning. James Murray, fireman of the passenger train, jumped, and was instantly killed.

Louisville, Ky., June 28.—A freight train on the Kansas City, Memphis & Birmingham Road jumped the track near Horse Creek to-day and was wrecked. Engineer Bois Clair escaped by jumping, but was internally injured. The fireman, Jack Hale, was caught under the locomotive and scalded and crushed to death.

Wheeling, W. Va., June 28.—Otto Bowers, a locomotive fireman on the Baltimore & Ohio Railroad, was thrown under the wheels and crushed to death while jumping from his engine this afternoon.

Chicago, Ill., June 29.—Spikes were driven into a switch and along the Chicago & Alton tracks near Sixteenth Street this morning; an engine pulling a freight train was derailed and thrown on its side. The engineer and fireman escaped with bruises.

Our report for June, it will be seen, includes 39 accidents, in which 14 engineers and 12 firemen were killed, and 20 engineers and 10 firemen were injured. The causes of the accidents may be classified as follows:

Boarding train in motion	1
Boiler explosion	1
Broken truck	1
Bursting lubricator glass	1
Collisions	9
Defective bridge	3
Derailments	6
Falling from engine	2
Landslide	1
Rails spreading	1
Strikers	4
Struck by cylinder-head	1
" " engine	1
" " obstruction	3
Train wreckers	4
Total	39

PROCEEDINGS OF SOCIETIES.

Engineers' Club, Philadelphia.—At the meeting of June 16, Mr. Benjamin Franklin read a discussion on Mr. Schermerhorn's paper on the Improvement of the Delaware River at Philadelphia. He disagreed with Mr. Schermerhorn's conclusions to the effect that, as the Delaware River is not a silt-bearing stream, properly located, artificial channels would remain of permanent depth, and argued that permanency of result could best be obtained by regulating works, and that no dependence can be placed upon dredging without such auxiliary structures.

Association of Engineers of Virginia.—At a recent meeting M. Rene de Saussure presented a paper on the Reproduction of Color by Photography. In describing the process, he stated that the only difference between this and the ordinary process was, that ordinarily used is the finer preparation of the plates and the introduction of a mirror immediately behind the plate. The principles involved are the relative lengths of the waves of light for the different colors and the interference produced by the reflective rays acting with the direct rays of light. The process is a very fine demonstration of the correctness of the wave theory of light, as the whole process is worked out on that theory as a basis. The one drawback to the colored photographs coming into common use is the fact that the plates have to be extra fine and sensitive, and have to be used within a day or two after they have been prepared, and so cannot be put upon the market for sale until improvements are made which will overcome this difficulty.

Master Car Builders' Association.—The Secretary has issued a circular relating to letter ballots that include the recommendation of the committees reporting at the last convention. A reference to our issue for July will give an idea of the scope of the recommendations, the first of which relates to the size of catalogues, specifications, etc.; the second is on wheel and flange gauges, which includes the following definitions:

1. Track Rails are the two main rails forming the track.

2. Gauge of Track is the shortest distance between the heads of the track rails.

3. Base Line, for wheel gauges, is a line parallel to the axis of the wheels, drawn through the point of intersection of tread, with a line perpendicular to the axis and passing through the center of the throat curve.

4. Inside Gauge of Flanges is the distance between backs of flanges of a pair of mounted wheels measured on a line parallel to the base line, but ¼ in. nearer to the axis of the wheels.

5. Gauge of Wheels is the distance between outside faces of flanges of a pair of mounted wheels measured on a line parallel to the base line, but 11/16 in. further from the axis of the wheels.

6. Thickness of Flange is the distance measured parallel to the base line between two lines perpendicular thereto, one drawn through the point of measurement of "inside gauge of flanges," and the other drawn through the point of measurement of "gauge of wheels."

7. Width of Tread is the distance measured parallel to the base line from a line perpendicular thereto, one drawn through the point of measurement of "gauge of wheels" to the outer edge of the tread.

8. Check Gauge Distance is the distance measured parallel to the base line between two lines perpendicular thereto, one drawn through the point of measurement of inside gauge of flanges "on either wheel, and the other drawn through point of measurement of" gauge of wheels on mate wheel.

9. Over-All Gauge is the distance parallel to the base line from outer edge of one wheel to the outer edge of mate wheel.

Note.—It should be understood, from the above definitions, that if the M. C. B. standards already adopted are taken, the above-mentioned wheel gauge will be directly, or by inference, as follows:

Inside gauge of flanges	4 ft. 5⅜ in.
Gauge of wheels	4 " 8⅛ "
Thickness of flange	1⅜ "
Width of tread	4⅛ "
Check of gauge distance	4 " 6¼ "
Over-all gauge	5 " 4⅜ "

The third is regarding the height of brake beams, which is placed at 13 in. to the center of new shoes above the rail for inside hung beams and 14½ in. for outside hung beams. Fourth, steel-tired wheels and their limit of thickness of tires, which should not be less than 1 in. above the tread and the throat of the flange. Fifth, safety chains. Sixth, lubrication of cars, in which an improvement is made in the design of the journal bearing and wedge by rounding the top of the latter instead of the top of the bearing. Seventh, regarding a set of journal-bearing and wedge gauges. Eighth, a modification of the dummy coupling hook. Ninth, a defect card for air brakes. Tenth, freight car trucks. Eleventh, ladders; in the latter case it is claimed that the distance of 3¼ in. which the round stands from the car is sufficient to allow the feet to slip through, and that 2½ in. instead of 3¼ in. should be made the standard.

INTERNATIONAL RAILWAY CONGRESS.

The fifth session of the International Congress of Railways will be held in London in June, 1895, as announced in our issue for June. The programme of papers has now been published, and is divided into five sections. The first section is on track and permanent way.

I. *Strengthening of Track with a View of Increasing the Speed of Trains.*—Model of tracks to be adopted for lines traversed by high-speed trains. Small increase of strength of existing tracks, so as to admit of an increase in the speed of trains :

A. Outline of rail. Determination of dynamic strains to be carried. Results of experiments.

B. Conditions of manufacturing and nature of the metal of rails. Comparison of soft with hard steel. Steel product : by the special process with the Bessemer converter ; by the basic process with the converter ; by both processes with the Martin furnace.

C. Rail connections. Strain carried by rail joints. Construction of the joint which will assure the most uniform resistance of the track at all points ; double-headed and Vignole rails.

D. Quality, dimensions, spacing.

E. Ballast : kind, method of placing. The committee to report on this is composed of M. W. Ast, Consulting Engineer to the Regency and Director of Track and Permanent Way of the railway of the North Emperor Ferdinand, of Austria, 50 Nordbahnstrasse, Vienna ; and Mr. Hunt, Engineer of Track of the Lancashire & Yorkshire Railway, Manchester, England.

II. *Special Points on the Track.*—Means used to do away with the slowing down of fast trains and avoiding shocks of passing special points on the tracks, such as curves of short radius, long grades, point switches, crossings, grade crossings, turn-tables, etc. This matter is in charge of M. Sabouret, Engineer of Bridges and Highways, Chief Engineer of Central Service of the Paris & Orleans Railway, 1 Valhubert Place, Paris.

III. *Junction Points.*—The most favorable conditions of the construction of junction points on tracks where high-speed trains are run, with a view of entirely doing away with slowing down. Best arrangements to adopt for points and ties. Best means to maintain speed of trains by doing away with the superelevation of the rail on curves at junction points. A. Zanotta, Chief Engineer of the Department of Maintenance Inspection, and Director of the Mediterranean Railway of Italy, Milan.

IV. *Construction and Testing of Metallic Bridges.*—*A.* What are the qualities of metal used and to be used in railway bridges, taking into account the specifications in vogue in different countries ?

B. What is the nature and value of the different methods used by various railway companies for periodical testing of metallic bridges ? What is the actual importance which can be given to these tests, and can they be regarded as an experimental means of establishing the effective conditions of solidity and the degree of safety on the said constructions ? Max Edler von Leber, Chief Inspector of corps I. and R. of the General Inspection Department of the Eastern Railways to the Minister I. and R. of Commerce, Vienna.

SECTION II.—LOCOMOTIVES AND CARS.

V. *Boilers, Fire-boxes and Tubes of Locomotives.*—*A.* Steel boilers in fire-boxes. Strains carried in service and conditions of acceptance of sheets.

B. Iron tubes. Means of avoiding cracks in tube sheets.

C. Injurious action exerted by the feed-water upon boilers and tubes. Systems of purification.

D. Programme of tests relative to the production of steam, to wit : Results given by tubes according to their diameter, their length, the system, their arrangement in the boiler and the metal of which they are made ; tests on the influence of the size of the smoke-box and different forms of stacks and spark arresters ; tests on the different systems of exhaust ; tests on the influence which speed may have on production of steam. Eduard Sauvage, Engineer of Material and Rolling Stock of the Eastern Railways of France, 168 Rue de Lafayette, Paris.

VI. *Locomotives for High-speed Trains.*—Type of engine best suited for high speed. Use of high pressures and the application of the compound principle. Improved method of distribution and balanced valve. Conditions of construction of locomotives, with a view to decreasing the dynamic strains exerted upon the track. Influence from the latter standpoint of the compound arrangement. Mr. Aspinwall, Chief Mechanical Engineer of the Lancashire & Yorkshire Railway, Horwich, England.

VII. *Cars for High-speed Trains.*—Type of cars for high-speed trains and for long runs. Flexibility and condition of train. Improvements made in the interior arrangement. Various methods of heating and lighting. Mr. Park, Carriage Superintendent of the London & Northwestern Railway, Ruelburton, England.

VIII. *Electric Traction.*—General system of electric traction. M. Auvert, Engineer of the Central Service of Material Department of the Paris, Lyons & Mediterranean Railway, Boulevard Diderot, Paris.

SECTION III.—TRANSPORTATION DEPARTMENT.

IX. *Acceleration of the Transportation of Merchandise.*—The influence of speed of transportation on the expense of traction and the utilization of railway stock on one hand, and on the efficiency of the rolling stock and the development of fixed installations on the other hand. Mr. Lambert, General Manager of the Great Western Railway, Paddington, London, W., England.

X. *Switching at Stations.*—*A.* Means of accelerating switching movements and the handling of merchandise. Arrangement of stations at starting-points. Mr. J. Richter, Director of the line from St. Petersburg to Varsouvia, of the Russian State Railway, Varsouvia Station, St. Petersburg, and Mr. Turner, General Manager of the Midland Railway, Derby, England.

B. Use of mechanical and electrical methods for accelerating the handling of merchandise and switching operations. Messrs. Eugene Sartiaux, Chief Electrician of the Northern Railway of France, 95 Rue de Mandenge, Paris ; and A. des Boschan, Engineer of the North Emperor Ferdinand of the Austria Railway, 50 Nordbahnstrasse, Vienna ; and M. Turner, General Manager of the Midland Railway, Derby, England.

XI. *Signals.*—Recent improvements in the block signaling apparatus, especially from the standpoint of saving of installation. Signals in tunnels. Means used to avoid collisions at dangerous points of high-speed lines in case of the breaking down of the stopping signals. Substitution of the language of colors by geometrical forms, with a view of avoiding the dangers resulting from color blindness or defects of vision. Messrs. Lucien Motte, Engineer of Track and Permanent Way of the Belgian State Railway, at Namur ; and Thompson, Signal Superintendent of the London & Northwestern Railway at Crewe, England.

XII. *Porterage and Tracking.*—Organization of trucking service for gathering in and delivery of goods from a private warehouse in connection with railway service. Mr. Twelvetrees, Chief Goods Manager of the Great Northern Railway, Kings Cross, London N., England.

SECTION IV.—GENERAL ORDER.

XIII. *Organization of Service of Central Administration on the Different Roads of Different Countries.*—Messrs. Ducker, Director General of the Roumania State Railway, and Professor in School of Bridges and Highways at Bucharest, Roumania, and Harrison, General Manager of the London & Northwestern Railway, Euston, London, N. W.

XIV. *Regulation of Lawsuits.*—The regulation of lawsuits which occur in the different railways having interchange relations. M. Dupeil, Director of the Russian Union of the International Relation of Railways, Italians Kaia, St. Petersburg.

XV. *Twenty-four-Hour Dials.*—Introduction of continuous points of enumeration from 1 to 24, and the division of the hour into 100 parts. Condition of the question. Partial application in different countries. Advantages to the public and to the service. The modifications of the dials of clocks that would be necessary, and how would it act in the affirmative ? M. Leon Scolari, Chief Inspector of the Mediterranean Railway, Italy, and Joseph Rocca, Inspector of the same road, at Milan.

XVI. *Decimal System.*—Generalization of the decimal system in calculations relative to construction and the management of railways. Means of facilitating the introduction of the metric system of weights and measures in countries where it is not in use. Mr. Wilkinson, Chief Goods Manager of the Great Western Railway, Paddington, London, W.

SECTION V.—ECONOMICAL RAILWAYS.

XVII. *Feeding Railways.*—*A.* Means used by the management of great lines to facilitate the building and operation of chief feeding lines. H. Debacker, Director-General of the Society of Economical Railways of Belgium, 52 Rue de Armour, Brussels, Belgium.

B. Facilities which can be guaranteed by the governmental authorities to favor the construction and operation of railways of light traffic, without injuring them in any way from the

standpoint of safety. A. C. Humphreys Owen, Member of the English Parliament, Administrator of the Cambrian Railways; and P. W. Meik, Member of the Institution of Civil Engineers of England.

XVIII. *Leases of the Operation of Chief Railways.*—What are the countries where leases have been applied? What are the conditions to which they have been applied, and what are the useful results which have been obtained therefrom? M. Du Burlet, General Manager of the National Belgium Railway, Société Nationale Belge des Chemins de Fer, Vicinaux, 26 Rue du Science, Brussels; and C. Colson, Engineer of Bridges and Highways, 50 Rue de Rennes, Paris.

XIX. *Depots of Chief Railways.*—Is it best to furnish the name of the depot at the center or at one end of the line? M. Terzi, Director of the Suzzara-Verrara, at Sermide, Italy.

XX. *Brakes of Different Railways.*—Study of the various systems of brakes applied to different railways. Technical conditions and conditions of safety. M. Ploq, Engineering Chief of the Operating Department of the Société Génerale des Chemins de Fer, Économique, at Arras.

ANNEX.

Technical reports to be gathered in conformity with the formulæ adopted by the congress on first section tracks and permanent structures.

A. Breakage of steel rails, by Mr. Bricker, Engineer of Track and Buildings of the State Railway of France, 136 Boulevard Raspail, Paris.

B. Cost of maintenance of metallic ties in comparison with those of wooden ties by M. Kowalski, Engineer of the Bone-Guelma Railway, Rue des D'Aslorg, Paris.

C. Operation of wooden ties of different kinds not injected, or injected according to different processes, by B. Hezenstein, Vice-President of the Commission on the Examination for the Preservation of Wood, 22 Nevsky Prospect, St. Petersburg.

SECTION II.—LOCOMOTIVES AND ROLLING STOCK.

D. Bent axles on locomotives, by M. Hodeige, Chief Engineer of the Belgium State Railways, 10 Rue des Cale.

E. Locomotive fire-boxes, by M. Hodeige, Chief Engineer of the Belgium State Railways, 10 Rue des Cale.

F. Locomotive boilers, by M. Beleroche, Chief Engineer of the Central Railway of Belgium, 76 Rue Belliard, Brussels.

G. Lubrication of cars, by M. Hubert, Chief Engineer of the Belgium State Railways, 19 Rue de la Loi, Brussels.

H. Switching engines, by M. Hodeige.

SECTION IV.—GENERAL ORDER.

I. Movement of *personnel* in different countries, by G. du Labeleye, Member of the Congress of Administration of the Congo Railway, 21 Place Louvain, Brussels.

Recent Inventions.

DE LAVAL'S STEAM TURBINE.

ONE of the exhibits at Chicago last summer which attracted perhaps as much or more attention from mechanical engineers than any other was the steam turbine which is the invention of Carl Gustav Patrik De Laval, of Stockholm, Sweden. This invention is very fully and clearly described in his American patent, which has recently been issued, and which we republish, almost entire, with the engravings—figs. 1 and 2—which are appended to it. In these specifications the inventor says:

"Heretofore in steam turbines, as well as in other steam-engines, the energy contained in the steam has been utilized in the form of pressure and the steam has performed its mechanical work during its expansion. According to my invention the steam is expanded in a nozzle or conduit of peculiar construction before it acts upon the turbine or bucket wheel. During this expansion of the steam in the nozzle or conduit the pressure of the steam is converted into velocity, and the energy contained in the steam is made use of after it leaves the nozzle or conduit in the form of its *vis viva*. The steam reaches the wheel in this expanded condition and rotates the wheel by its *vis viva*, while heretofore the steam was expanded within or against the turbine wheel or other movable part, which was so actuated by the pressure of the expanding steam.

"In the accompanying drawings fig. 1 is a front view of my improved steam engine, partly in section; fig. 2 is a fragmentary side view of the same, also partly in section.

"Like letters of reference refer to like parts in both figures.

"*A* represents a turbine wheel provided at its face with buckets *a*.

"*M* represents the steam nozzle which is fitted with its discharge end against one side of the wheel, so as to direct the current of steam against the buckets thereof. This nozzle has its receiving end connected with a steam-pipe or other steam supply which furnishes steam to the nozzle under a suitable pressure. The nozzle may be contracted from its receiving end to its narrowest portion *b*, which has the proper area to deliver the volume of steam which is required for performing the work for which the engine is designed. The nozzle is diverging or gradually enlarged in cross-section from this narrowest point to its discharge opening *c*, by which the steam is delivered against the buckets of the wheel. The axis of the nozzle is arranged at an acute angle to the plane of the wheel, and the end of the nozzle is arranged parallel with the side of the wheel, so as to fit as closely as possible against the same. This renders the diverging portion of the nozzle shortest at the point where the revolving buckets first reach the nozzle, and longest at the point where the buckets leave the nozzle.

"The buckets of the wheel are concavo-convex and arranged with the convex side forwardly, so that the side portion of each bucket which is adjacent to the steam nozzle stands about in line with the axis of the nozzle in passing by the latter, while the opposite side portion of the bucket stands about at right angles to the axis of the nozzle. This permits the steam current to enter between the buckets on the receiving side of the wheel with very little resistance.

"Scientific researches made by other investigators, as well as my own, have shown that when steam issues from a cylindrical or converging nozzle, the maximum of expansion which

FIG. 1.

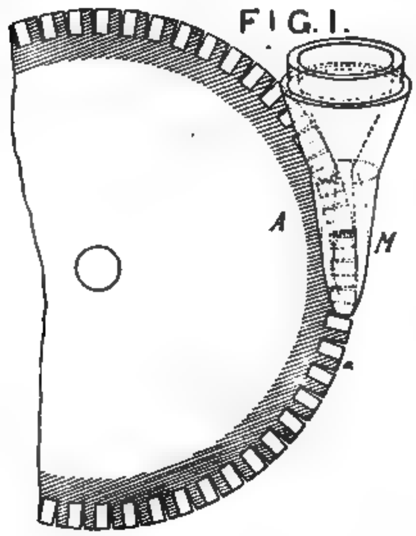
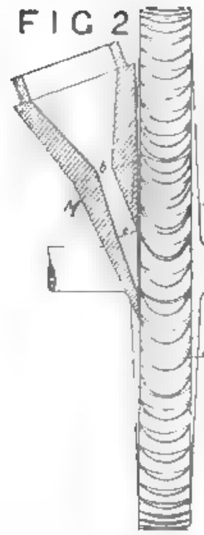


FIG 2



it is possible to attain by either of these forms of nozzles corresponds to 57.7 per cent. of the initial pressure. A certain amount of velocity and of *vis viva* is imparted to the steam by such nozzles, but a large amount of the pressure, more than one-half, is not converted into velocity, and the efficiency of such nozzles is therefore very low. I have ascertained that it is possible to expand the steam to or below the atmospheric pressure by a diverging or flaring nozzle, and to convert all the energy contained in the steam into *vis viva*.

"In my improved nozzle, as shown in the drawings, the converging portion of the nozzle serves principally to reduce the cross-section of the outlet to that area which will emit the necessary quantity of steam. In engines of ordinary size, this area of the narrowest portion of the nozzle is so small that the steam supply pipe has to be much larger in diameter in order to render its connection with other fittings convenient and to avoid excessive friction in the pipe, but while the converging portion of the nozzle is therefore desirable, it is not indispensable.

"The steam current, when leaving the narrowest part of the discharge nozzle, has reached the maximum of expansion which is possible in a straight or contracted nozzle, and the pressure under this degree of expansion is equal to 57.7 per cent. of the initial pressure. In the diverging nozzle, the pressure is still further reduced by expansion and the speed of the current is correspondingly increased so that, at the discharge end of the diverging nozzle, the pressure has nearly dropped to that of the atmosphere or to that of the fluid or medium into which the nozzle discharges, and practically all

the pressure of the steam has been converted into velocity. In other words, the 57.7 per cent. of the initial pressure, which existed in the steam current at the throat or narrowest point of the nozzle, is converted into velocity by expansion in the diverging nozzle.

"The diverging nozzle is so proportioned that the speed of the steam increases as it passes through the nozzle. In order to attain this result the divergency of the nozzle should be such that the areas of succeeding cross-sections of the nozzle increase in a lesser degree than the volume of the steam from cross section to cross-section. The speed of the steam at each given cross-section of the nozzle depends upon the proportion between the passing volume of the steam and the area of the cross-section, and under the proportion stated the volume of the steam in passing through the diverging nozzle increases in greater proportion than the areas of the cross-sections of the nozzles, whereby the velocity of the steam is correspondingly increased.

"As an illustration it may be stated that a nozzle in which the diverging portion has a diameter of $\frac{1}{8}$ of an inch at its narrowest point, a diameter of $\frac{3}{8}$ of an inch at its discharge end, and a length of 8 in., will expand steam of 165 lbs. pressure per square inch down to 3 lbs., and will produce a steam current of corresponding velocity.

"With a properly proportioned diverging nozzle, the steam issues from the nozzle in a compact jet, which has no tendency to further expand or change its pressure or specific gravity, hence there is no tendency for the steam to leak at the sides of the wheel, but the entire jet is bodily thrown against the wheel and made effective in actuating the same.

"The steam current issuing from the nozzle with little or no pressure, but great velocity, strikes the buckets of the wheel and revolves the latter at an exceedingly high rate of speed, in many cases higher than 15,000 revolutions per minute. The practically complete conversion of the pressure of the steam into velocity and the utilization of the *vis viva* of the swiftly moving current of steam renders this engine very economical in the consumption of steam while its construction is exceedingly simple.

"From what has been said, it is evident that all necessity of tightening against steam pressure ceases at the end of the nozzle. In this consists one of the advantages of my steam turbine above all other constructions where steam is admitted to the turbine under pressure, and consequently leaks out at all sides instead of passing through the turbine wheel. The live steam does not come in contact with any of the working parts of the turbine, and the machine therefore works equally well with superheated as with saturated steam. Here is also an opportunity for economizing heat, which is impossible in ordinary steam-engines on account of the sensitiveness of the packing boxes to heat.

"The economy of this turbine has been established by numerous trials. For instance, with a 50-H.P. turbine dynamo an effect of 63.7 H.P. was obtained with a consumption of 19.73 lbs. of steam and 2.67 lbs. of coal per hour and H.P.

"I am aware that in Williams on 'Heat in its Relations to Water and Steam,' pp. 235–44, a theory is set forth which apparently does not agree with that set forth in the foregoing description, but whether this disagreement be real or only apparent, the fact is that the statements contained herein are correct and based upon many carefully conducted trials of steam turbines provided with the various nozzles referred to, which trials have extended over a considerable period of time and were made under widely different pressures.

"I claim as my invention—

"1. The combination with a bucket or turbine wheel, of a stationary nozzle opening adjacent to the wheel and having its bore diverging or increasing in area of cross-section toward its discharge end, whereby the elastic fluid under pressure is expanded in passing through the diverging nozzle and its pressure is converted into velocity before the jet is delivered against the wheel, substantially as set forth.

"2. The combination with a bucket or turbine wheel, of a stationary nozzle opening adjacent to the wheel and provided with a contracted receiving portion and with a discharge portion having its bore diverging or increasing in area or cross-section toward its discharge end, substantially as set forth.

"3. The combination with a turbine wheel provided with concavo-convex buckets, of a stationary nozzle arranged at an acute angle adjacent to the side of the wheel and provided with a discharge portion having its bore diverging or increasing in area of cross-section toward its discharge end, substantially as set forth.

"4. The combination with a bucket or turbine wheel, of a stationary nozzle arranged to deliver a jet of expansive fluid against the wheel, and having its cross-sections increasing in area toward its discharge end in a lesser degree than the increase of the volumes of the fluid passing through the respective cross sections, whereby velocity is imparted to the fluid during its expansion in the nozzle, substantially as set forth."

The patent is No. 522,066, and dated June 26, 1894.

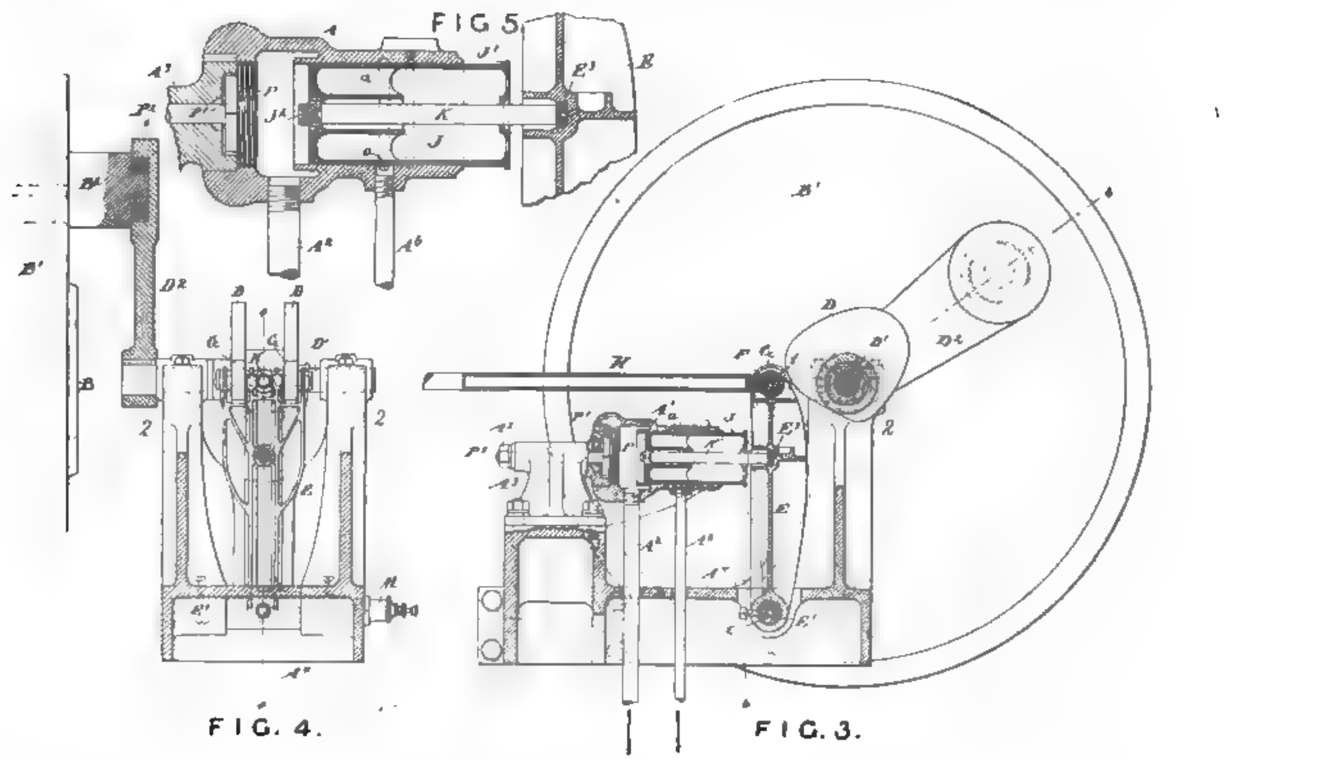


FIG 5. FIG. 4. FIG. 3.

STEAM-ENGINE.

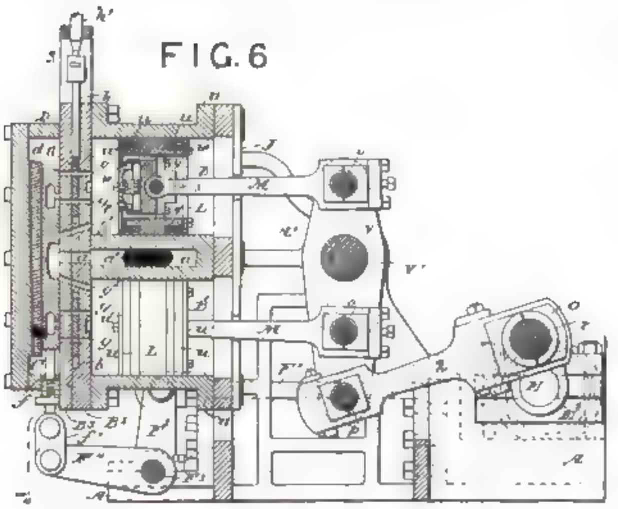
Charles T. Porter, of Montclair, N. J., has patented the arrangement for operating a piston or slide-valves of steam-engines by a cam, which is shown in figs. 3, 4 and 5. Fig. 3 is a front view, looking at the fly-wheel and crank of the engine, with the valve-operating mechanism shown in section.

Fig. 4 is a transverse section drawn on the line 6 6 of fig. 3, and fig. 5 is a view of some of the parts shown in fig. 3, but drawn to a larger scale. Two cams, *D D*, are mounted on a shaft, D^1, which is supported on a stand or bearings, 2, 2, attached to the engine frame or bed-plate. This shaft is driven by a return crank, D^2, which is fastened to the crank-pin B^2. *E* is a lever which is journaled in the fixed bearing E^1. The upper end of this lever has two rollers, *G G*, attached to it which bear against the cams *D D*. A^1 is a cylinder also attached to the engine frame, and provided with an elongated piston, *J*, and a piston-rod, *K*. This rod has rounded ends, which rest in corresponding bearings J^2 in the piston and E^2 in the lever. A^2 is a pipe by which steam, compressed air, or other fluid is conducted to the cylinder A^1, and which forces the piston *J* outward and presses the rod *K* against the lever *E*, and thus keeps the rollers *G G* in contact with the cams *D D*. The rod *H* is connected with the valve, which is thus operated by the action of the cams *D D*. These cams, it is claimed by the inventor, can be made of such a form as will produce a better distribution of steam than is possible with an eccentric. The form which he proposes for these cams is fully described in the patent, which is numbered 517,983, and dated April 10, 1894.

QUICK-SPEED STEAM-ENGINE.

Mr. John P. Devoissaud, of Sherman, Tex., is the inventor of the steam-engine, a longitudinal section of which is represented by fig. 6. It consists of two single-acting cylinders, *B* and B^1, the pistons of which are connected to an oscillating beam, *N*, which in turn is connected to a crank-shaft, *E*, by a connecting-rod, *Q*. Both pistons are operated by a single slide-valve, *C*, which is moved by an eccentric *F*, rod F^1, rock-shaft F^2 F^3 F^4, and valve-stem *f*, in a manner which will be apparent from the engraving without other explanation. *G* is a throttle-valve, but the object in constructing it in that form

FIG. 6



is not apparent. The inventor has evidently aimed to balance one piston by the movement of the other. The patent is numbered 519,943, and dated May 15, 1894.

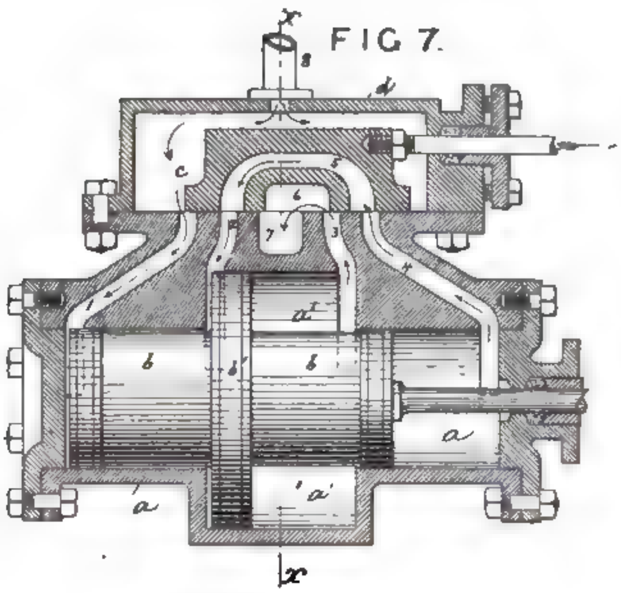
STEAM-ENGINE.

Mr. Benjamin Franklyn Sparr, of Brooklyn, N. Y., has patented the form of compound engine, the cylinder of which is shown by fig. 7, and is described as follows in his specifications:

"The letter *a* represents a steam cylinder provided with an enlarged central chamber, *a'*, and with contracted ends at both sides of said chamber. The piston-head *b* is provided at its center with a fixed collar, *b'*, adapted to reciprocate within chamber *a'*, while the two ends of the piston are of a size to engage the two contracted ends of the cylinder. The cylinder *a* is provided with four ports, 1, 2, 3, 4, of which the ports 1 and 4 enter the extreme ends of the cylinder itself, while the ports 2 and 3 enter opposite ends of the chamber *a'*. The valve *c* is provided with the steam duct 5, adapted to register with the ports 1, 2, 3, and 4, and with a duct, 6, adapted to register with the exhaust 7.

"The operation of the engine will be readily understood. Steam enters the valve chamber *d*, through pipe 8, and passes into port 1, to move the piston toward the right. The valve *c* will move past port 1, to open the same fully. At the same time the steam from port 4 will pass through duct 5 and port 2, against the left-hand face of collar *b'*, to assist the steam entering through port 1. The steam from the right-hand side of collar *b'* goes to the exhaust by passages 3, 6, and 7. When the piston has reached its extreme position, the operation of the parts is reversed. That is to say, the live steam enters port 4 from the valve chamber, and the steam from

FIG 7.



the left-hand end of the piston passes through port 1, duct 5, and port 3 to the right-hand side of collar *b'*. The steam from the left-hand side of such collar is exhausted through passages 2, 6, and 7."

It is not clear from the engraving how the central piston or "collar *b'*," as the inventor calls it, could be put into the large cylinder or central chamber *a'*. It would seem to be essential to make the small cylinders, or one of them, separate from the large one and then bolt them together. The plan appears to have considerable merit, and is especially adapted to compound locomotives.

The number of the patent is 520,456, and its date May 29, 1894.

CAR BUFFER.

Mr. William F. Richards, of Buffalo, N. Y., is the inventor of the arrangement shown by fig. 8, and has assigned the patent to the Gould Coupler Company.

He has described his invention as follows in his specifications:

"This invention relates to the buffers or yielding platform extensions which are applied to the ends of railway cars, and more especially to buffers of this kind which are capable of an oscillating motion, so as to accommodate themselves to the position of the cars in rounding curves. These buffers are provided with extension springs for holding them in contact with the buffer of an opposing car, so as to form a continuous platform between the cars. When the cars are coupled, the extension springs of the buffers are compressed, and in order to permit the cars to be easily coupled and uncoupled, the springs must be comparatively light.

"My invention has for its object to provide the buffer with simple and inexpensive means whereby an increased or supplemental pressure may be applied thereto, after the cars have been coupled, so as to hold the buffers of opposing cars in firmer contact with each other and thereby check or avoid the disagreeable rolling or swaying motion of the cars, without, however, interfering with the easy coupling or uncoupling of the same.

"Fig. 8 is a sectional top plan view of the platform and adjacent portion of a railway car containing my improvement, the flooring being omitted to expose the parts underneath the same.

"*A* represents the longitudinal timbers of the stationary car platform, *B* the cross timber connecting the outer ends of the longitudinal timbers, and *C* the end sill of the car body.

"*D* is the buffer or yielding platform extension which preferably consists of a transverse vertical buffer plate having at its upper end a horizontal threshold plate, *d*, extending inwardly over the end timber *B* and overlapped by a foot-plate, *d'*, secured to said timber.

"*E* is the main buffer stem which carries the buffer and which is guided with its outer portion in a central opening formed in the end timber of the platform, and with its contracted inner portion in an opening, *e*, formed in a block, *E'*, secured between the longitudinal central timbers of the platform.

"*F* is the light extension spring of the buffer, which surrounds the contracted inner portion of the buffer stem between the collar or shoulder *f* of the latter, and the bottom of a horizontal socket, *g*. This socket is arranged in a horizontal eye or collar, *h*, formed centrally in a transverse follower or abutment bar, *H*, which latter is arranged to move toward and from the end timber of the platform and is guided in slots or recesses *h'* formed lengthwise in the longitudinal timbers of the platform. The socket *g* is provided at its front end with an annular flange, *g'*, which bears against the front side of the follower *H*, and whereby the socket and the rear end of the extension spring are compelled to move forward with the follower. When in its rearmost position the socket *g* is seated with its rear end in a recess, *i*, formed in the block *E'*.

"*I* is the usual main or heavy buffer spring which surrounds the light extension spring and sustains any heavy shocks that overpower the latter. When this heavy spring comes into action, it is compressed between the collar *f* of the main buffer stem and the flange of the socket *g*.

"*J J* represent the side stems or stay rods of the buffer, which are pivoted at their front ends to the buffer on opposite sides of its pivot and which carry the usual righting springs *K*. These side stems are guided with their front portions in openings formed in the end timber *B*. Their rear portions may be guided in openings formed directly in the end portions of the follower *H*, but they preferably slide in movable tubes *k*, as described and shown in Letters Patent of the United States, No. 495,061, granted to me April 11, 1893, by which construction the side springs serve to hold the buffer from rattling when the cars are uncoupled as well as to right the same. Any other suitable or well-known spring mechanism for projecting the buffer may, however, be employed, if desired.

"*L L'* represent a pair of pressure cylinders arranged in rear of the follower *H*, on opposite sides of the platform center, and each containing a piston, *l*. Each of these pistons has a rod, *l'*, which passes through an opening formed in the front head of the cylinder and is attached at its outer end to the follower, preferably by a vertical bolt, as shown in fig. 1. The pressure cylinders may be supplied with any suitable fluid under pressure for actuating their pistons, but they are preferably supplied with compressed air from an auxiliary reservoir, *M*, connected by a pipe, *m*, with the reservoir which supplies compressed air for applying the brakes of the car. A reducing valve, *m'*, of an ordinary construction is preferably arranged in the pipe *m*. m^2 is the main supply pipe connected with the auxiliary reservoir, and m^3 m^4 are branch pipes leading from said pipe to the rear ends of the pressure cylinders.

"*N* is a three-way cock or valve, of any suitable construction, arranged in the main supply pipe m^2, and having its ports so arranged that upon turning the valve in one direction the pressure cylinders are placed in communication with the reservoir, while upon turning it in the opposite direction, the supply of air to the cylinders is shut off and the air in the same is allowed to escape, to permit the pistons to return to the rear ends of the cylinders.

"In the normal position of the parts, before the cars are coupled, the follower is in its rearmost position and bears against the rear ends of the recesses in which it is arranged, and the pistons of the pressure cylinders are at the rear extremity of their stroke, as indicated in fig. 8. In this position of the parts, the follower *H* serves merely as a stationary rear abutment for the various springs of the buffer, and upon coupling the cars, the buffer is pressed inward in the ordinary manner. After the cars have been coupled, compressed air is admitted to the pressure cylinders by properly turning the three-way valve in the main pipe m^2. The compressed air entering the cylinders behind their pistons forces the latter to the front end of the cylinders, thereby moving the follower forward with the same, and further compressing the several springs between their abutments. The supplemental pressure thus applied to the springs is exerted upon the buffer, causing the same to be pressed with correspondingly increased force against the buffer of the opposing car, thereby restraining the movements of the buffers upon each other and avoiding the unpleasant rocking or swaying motion of the cars which is permitted by an ordinary spring buffer.

"When it is desired to uncouple the cars, the three-way valve of the main air-pipe is turned in the proper direction to shut off the further supply of air to the pressure cylinders and permit the air to escape therefrom. The pressure being now removed from the rear side of the follower, the compressed springs expand to their former light tension and return the follower to its normal position, permitting the cars to be uncoupled without difficulty."

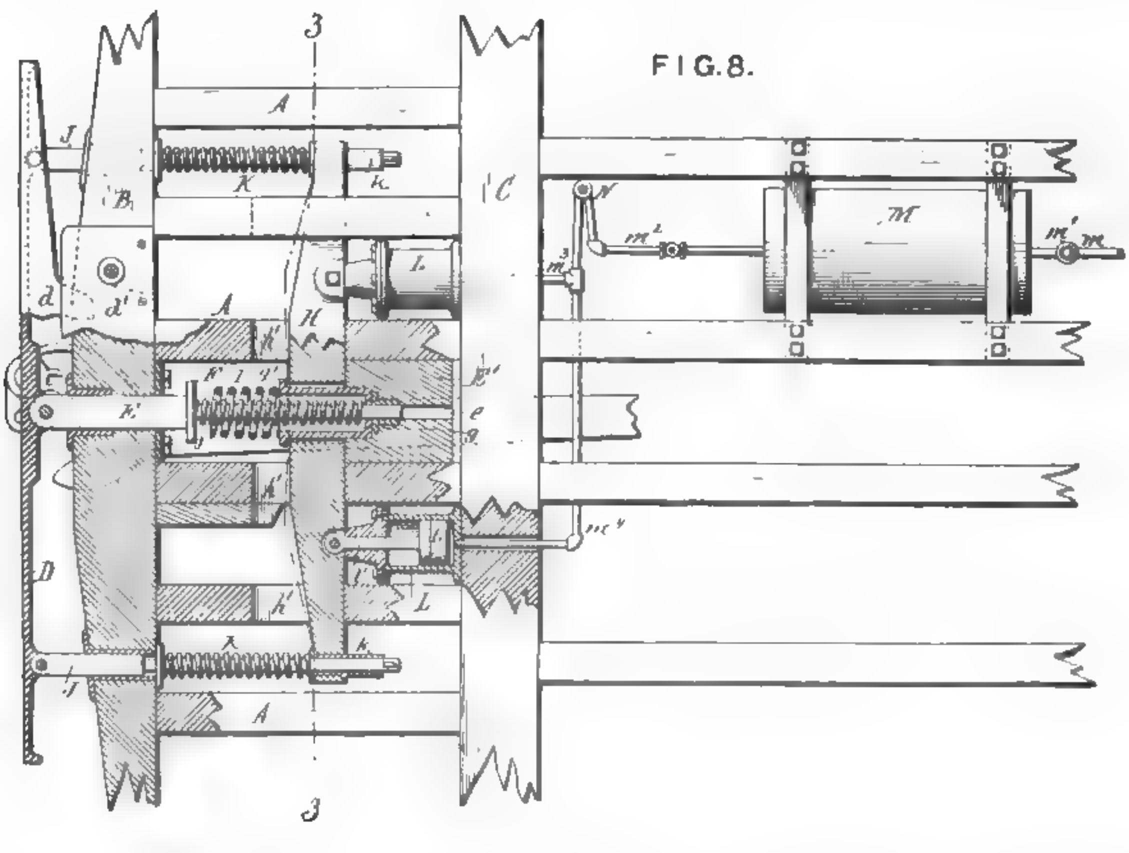


FIG. 8.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

Formerly the RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

The American Railroad Journal, founded in 1832, was consolidated with Van Nostrand's Engineering Magazine, 1887, forming the Railroad and Engineering Journal, the name of which was changed to the American Engineer and Railroad Journal, January, 1893.

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NEW YORK, SEPTEMBER, 1894.

EDITORIAL NOTES.

THE fact that it is possible for a sea-going vessel to go from the Gulf of St. Lawrence to the Great Lakes by way of the Canadian canals has served as a spur for a number of years to the congressional representatives of the States bordering on these inland seas to press the construction of a ship canal from the lakes to the sea in the territory of the United States. A bill to secure an appropriation sufficient for a preliminary survey is now before the House, but its chances of passing are exceedingly slim, owing to the facts that the amount ($100,000) would be a mere bagatelle as compared to the total expenses and that now is the era of retrenchment.

IT is almost startling, when we remember that in 1887 the first really commercially successful electric railway was started in Scranton, Pa., to read that articles of incorporation for a network of electric railways that will connect Jersey City and Philadelphia have been filed. There is no reason why such roads should not be built, for the whole distance is dotted with thriving towns, like beads on a string, and the constant desire of man to be somewhere else than where he now is leads him to patronize the trolley and go to the next town. A similar system of interurban roads already exists in the coal regions of Scranton and Wilkesbarre, and it is doing a thriving business. How long it will be before these roads can compete with the steam lines for through passenger and all freight business the future alone can tell.

WE wish to call particular attention to our report of accidents to locomotive engineers and firemen for the month of July that appears in another column. Out of the 50 accidents that are reported, there are 11 that are attributed to train wreckers and strikers. In every instance but one they were credited to the account of the strikers. In these 11 accidents six engineers and four firemen were killed, and four engineers and three firemen injured. It is poor consolation for the families of these men to know that they were killed and injured in the performance of their duty. It was a case of mob violence, exerted by one set of men against their mates, unreasonable and unreasoning, and the results have been so disastrous, and so many innocent people have been made the victims of this blind wrath, that there seems to be many very good reasons for classing attempts at train wrecking with murder in the first degree.

NEWS of the battles that have taken place between the Chinese and Japanese during the existing state of unpleasantness is so exceedingly meager that we really know almost nothing about them. But viewed through the mist that shrouds operations on the Asiatic coast, it would seem that the personal equation is quite as important a factor in the sea fights conducted with turreted battle ships as it was in the old struggle against the Spanish Armada in the English Channel. The know-how and the vim seems to count; and while the Japanese navy seems confessedly weaker than that of their opponents from the standpoint of armor and armament, they appear to be getting the best of it. As this is the first war that has given an opportunity to test the modern war ship's capacity as a fighting machine, the engineering world will watch with interest the development of the relative values of guns, armor, torpedoes and the ram.

THE remarkably clear comparison of the working of locomotive, stationary and marine engines published in another column should go far toward straightening out the entanglement of ideas that now prevail regarding the use of the compound locomotive. The facts, briefly stated, seem to be that for the economical consumption of steam the locomotive compares favorably with both marine and stationary engines of the same type, and that the compound will effect a saving over the single expansion locomotive when it is worked under a higher steam pressure. In the dispute over the compound-single-expansion question, the use of the higher pressures by the compounds has been claimed to give it an unfair advantage over the single expansion. M. Desdouits, however, claims to have proven that these high pressures can only be economically used in connection with the compound engine, and it therefore has a right to use them in any and all competitive trials.

A DECISION has recently been rendered by an English court that to us has the appearance of a decided novelty in the standpoint taken relative to the liability of railroads for damages. A train of the Midland Railway Company was timed to start at 5.18 A.M. The plaintiff, who was a miner, took a ticket to travel by that train to his work. He waited at the station until 7 A.M., when the train had not then arrived. As at such time it was too late to be allowed to go down the pit to do that day's work, he went home. He brought an action against the railway company to recover the day's wages he thus lost. The Court of Appeal decided that as there was unreasonable delay in starting the train the plaintiff was entitled to recover. In view of such precedent, it would be interesting to see what stand an American court would take, and whether the fact of habitual tardiness would be detrimental to the company's case, especially where it protects itself with the notice that the "company reserves the right to change the time of any or all of its trains without previous notice, and only posts this time-table for the convenience of the public to show when trains may be expected." It would probably be diffi-

cult to collect damages from a company shielded behind such a notice and defended by a shrewd lawyer, who would take advantage of every technicality; and yet there should be some redress, for in selling a ticket the company virtually agrees to perform a certain service at a certain time, which, in the case of a delayed train, it does not do.

THE PROCEEDINGS OF THE MASTER MECHANICS' ASSOCIATION.

Reviewing the proceedings of a number of meetings, like those which the Master Mechanics hold annually, is a little like writing history, in that it is not easy to regard the events which have transpired, the facts which have been adduced, the theories and arguments which have been advanced as calmly and dispassionately at the time the events are occurring, or immediately after, as is possible when the whole proceedings are condensed into one volume, and are in a convenient form for reference and study. The report of the twenty-seventh annual convention, which was held at Saratoga Springs in June, has now been received, and invites examination, comment and criticism.

The first observation which suggests itself is the very neat cover which the Secretary has designed and in which the volume is bound. It is of a pale green color, with the title printed in what in schoolboy days we called "old English" type, below which is a skeleton view in outline, with the main parts represented in a gray tint, of the Baldwin compound engine *Columbia*, which was exhibited in Chicago. The Baldwin Company, it is thought, has never done this engine full justice in the photographs and other illustrations of it which they have published. These have all been "quartering" views, looking toward the front of the machine, and remind one of the pictures in the illustrated papers of the new prince, recently acquired in England, whose head is made the prominent object in the portraits. These and the photographs of the *Columbia* make one think of those embryonic creatures which consist principally of head. It is hardly necessary to add that this impression is an unfair one both for the prince and the *Columbia*. Mr. Sinclair has given us a full side view or elevation of this locomotive which indicates its impressive proportions, although very few details are shown.

The President, in his annual address, pointed out that, owing to the general depression in business, the most urgent duty resting on the members of the Association is the reduction of the cost of operating locomotives, and many of our readers will probably sympathize with him when he speaks of "the incomprehensible policy of rate cutting."

The reduction of fuel consumption, he points out, is the direction in which the greatest economy may probably be made; and the compound locomotive, he thinks, offers the most hopeful means of attaining such economy. Next to this source of saving, increased facilities and conveniences for making repairs is the direction in which locomotive superintendents must look for a saving.

He had a good word to say for the work of the various railroad clubs which hold their meetings at different places during the year, and suggests the amalgamation of the Master Mechanics' and Master Car Builders' associations—a proposition which comes up annually, but which this year was opposed by some of the supply dealers, who objected to lessening the period of time during which they can exert their influence on the members of the two associations.

The President also suggested that the time has arrived when the associations should consider the question of making arrangements with some established institutions of learning whereby the co-operation of its professors and the use of its scientific apparatus for the investigation of technical subjects could be obtained. The Secretary afterward reported the results of his efforts to raise a fund of $5,000 for making tests of locomotives, which failed owing to the hard times, although he seemed to entertain the hope that when "the clouds roll by" the scheme might succeed. He reported that most of the railroad presidents with whom he had interviews advised that the enterprise be abandoned for the present. Later in the proceedings a committee was appointed, on motion of Mr. Lauder, to suggest what action should be taken to secure the co-operation and aid of the American Railway Association in getting funds for making such tests. This committee afterward made a report, and recommended that another committee of three be appointed to confer with the American Railway Association with reference to this subject, and that a committee of five be appointed "to outline work and to conduct and supervise such tests as may be decided upon." Such committees were appointed, and have authority to take action.

There was also a very elaborate report made by another committee, appointed last year, on Standard Tests of Locomotives, and which occupies 25 pages of the printed proceedings. In this dissertation the committee describe very elaborate methods of making such tests, and give in great detail the data which should be ascertained. After discussion the report was adopted as one of the standards of the Association. It is not quite clear what the significance of this action is. Does it mean that, if any one undertakes to test a locomotive, they are recommended to do it in the manner described by the committee? This seems to be very much as though an association of doctors should get together and adopt a standard method of diagnosing disease. In making experimental investigations we generally want to learn the cause of some phenomena or deficiency which we don't understand and can't explain, or learn something which we don't know. The success of an experimenter in making discoveries depends very often on his ingenuity, his skill or the acuteness of his reasoning powers in making deductions from not only the facts which he observes, but in the detection of facts which should be observed. The experimental investigations which give the most valuable results are not those which follow beaten paths, but those which depart from them and adopt new and original lines of research and new expedients for increasing knowledge. Standardizing methods of scientific research and discovery seem to be a sort of Chinese way of finding out things which we don't know. The report contains many very excellent and valuable suggestions with reference to the testing of locomotives, but it is difficult to see any good reason for making them standard methods.

Mr. Barnes called attention, too, to the fallacy of referring the consumption of coal to the dynamometer H.P., which is recommended in the report for the reason that the work done by a locomotive is not only that required to pull the cars, but it must also pull itself and its tender. The amount of fuel consumed in doing this was shown by the test which Mr. Buchanan made and which is reported on another page. There is, of course, a rate of ascent on which a locomotive could only pull itself. In such a case, while it might in every way be working very economically, no power at all would be developed on the dynamometer, and yet by the action of the Association that way of estimating coal consumption is now the "standard" way.

The substance of the report of the Committee on Cracking of Back Tube Sheets is summed up in their deductions from the replies to their circular of inquiry, in which it is said: "First, that radial stayed boilers carrying high pressure are more subject to cracked tube sheets than other types." The cause of this is assigned to too rigid staying of the crown sheet next to the flue sheet, placing flue holes too close to the flanges and possibly to too high steam pressure. The cure proposed in the report and in the subsequent discussion is to

allow more flexibility in the crown sheet directly back of the tube sheet either by placing the stay bolts further back or putting in a different kind of stay next to the tube sheet, which will allow it and the crown sheet to expand upward without straining the stays. There was nothing very new evolved by the discussion, but it confirmed what has long been known, that the fire-box is the most troublesome part of a locomotive.

The report of the Committee on Oiling Devices for Long Runs had nothing that was very noteworthy. It describes with considerable detail the practice on a number of English and American roads, and has an appendix added on Oils and Oil Tests.

The report on Boiler and Fire-box Steel excited much interest, as the committee proposed standard specifications to be adopted by the Association. The main question at issue seemed to be the ultimate strength which fire-box steel should have. Some of the members favored a soft steel with an ultimate strength ranging from 50,000 lbs. to 58,000 lbs., while the majority preferred a harder quality, with an ultimate strength of 55,000 lbs. to 65,000 lbs. In their efforts to get positive information concerning the performance of hard and soft fire-box plates, the committee had tensile tests made of specimens of steel both before and after service. This strength varied from 77,000 lbs. down to a little over 50,000 lbs., and the mileage service from a little under 500,000 miles to a little over 50,000 miles. In the discussion which followed, Mr. Gibbs, of the Chicago, Milwaukee & St. Paul Road, said that they had tabulated the results of the service of about 250 fire-boxes on his road, and that in one class of engines the highest mileage of any fire-box, which was a little less than 500,000 miles, was given with a 77,000 lbs. steel. In another case he found that in one of the fire-boxes which gave nearly the highest mileage the plates had phosphorus as high as .13, whereas they were specifying .035, and they found in a great number of the old fire-boxes that gave splendid service "chemistry that seems perfectly wild." The committee concluded, however, that the weight of evidence was in favor of steel of 60,000 lbs. tensile strength giving the best results. The following are the standard specifications which were recommended by the majority of the committee, and were finally adopted excepting as indicated in the foot-note, and are probably the specifications to which manufacturers will be obliged to conform hereafter:

Metal is to have tensile strength of 55,000 lbs. to 65,000 lbs., with 60,000 lbs. desired, and 28 per cent. elongation preferred. The chemistry desired is:

Carbon	.18
Phosphorus, not above	.03
Manganese " "	.40
Sulphur " "	.02
Silicon " "	.02

Plates will be rejected having:

1. Tensile strength less than 55,000 lbs.
2. Tensile strength over 65,000 lbs.
3. Elongation less than 22 per cent. in 8 in., and in ¼-in. plates not less than 20 per cent. in 8 in.
4. Failure to stand bending and quenching test as for shell steel.
5. Any seam or cavity more than ¼ in. long in any of the fractures of homogeneity test.

CHEMICAL.

Carbon	.25
Carbon, below	.15
Phosphorus, over	.045*
Manganese "	.45
Silicon "	.03
Sulphur "	.035

* This, on motion of Mr. Mitchell, was changed to .035.

Homogeneity test is made in the following manner:

A portion of the broken test piece is nicked with a chisel on opposite sides alternately, nicks being about 1 in. apart. Test piece is then firmly held in vise and broken by a number of light blows, bending being away from the nicks.

Laminations more than ¼ in. long to condemn.

During the discussion some curious statements were made. Mr. Vauclain, for example, recommended that every master mechanic should employ a chemist and start a laboratory, and said that they could hire a chemist for a great deal less money than they can hire a good mechanic, and that after they have had him a short time and have found out the value of such a man they would be willing to pay him the best wages paid about the establishment.

Mr. Dean thought that the elastic limit in steel should not be ignored, to which Mr. Gibbs, chairman of the committee, replied that the reason they did not specify anything on the subject of elastic limit was, first, that they did not know anything about it; secondly, the strains that they designed for were 14,000 lbs. per square inch, and that is so far below the elastic limit for any steel they knew of that they did not think it necessary to discuss it. This "reminds us of a little story" current in the daily papers recently of the man who said he had just met a *great* physician. His friend asked how he knew he was a distinguished doctor. "Why," he said, "I asked him what was the best cure for consumption, and he said he didn't know."

Mr. Gibbs added further to the discussion the statement that he had been unable to find any difference whatever in the service of steel of 50,000 lbs. and 60,000 lbs. ultimate strength in regard to the life of the sheet. Mr. Forsyth, of the Chicago, Burlington & Quincy Railroad, confirmed this by the statement that he thought "the tendency is to think that if a fire-box sheet cracks the steel is of high strength and high carbon; but he thought the results of a great many tests have shown that soft steel—low-strength steel—is just about as liable to crack as high steel."

The report and discussion have shown that the members of the Master Mechanics' Association do not know all that it is desirable should be known about fire-box steel, and that the fire-boxes are still, as they have always been, the most costly parts of the machine to construct and the most troublesome and expensive to maintain. To be rid of the troublesome steel plates, which behave so badly, would be a great boon.

It was intended, when this review of the proceedings of the Master Mechanics' Association was commenced, to complete it in one article, but about a half of the report of the proceedings, including the interesting discussion on compound locomotives, still remains. Our review must, therefore, be divided into two parts, and the publication of the conclusion be postponed to our October number.

NEW PUBLICATIONS.

THE CAR INTERCHANGE MANUAL. *A Compendium of Useful Information for Master Car Builders and Car Inspectors, Including an Abstract of the Decisions of the Arbitration Committee of the Master Car Builders' Association.* Compiled by J. D. McAlpine. Published by the *Railroad Car Journal*, New York. 86 pp., 3¾ × 5¼ in.

The title gives a very good description of the general character of this book. It is composed chiefly of abstracts of decisions of the arbitration committees of the Master Car Builders' Association subsequent to May, 1888, of disputes arising under the rules for the interchange of cars. What is of equal value to these decisions is an excellent index to them. The decisions are followed by a table of words often misspelled on defect cards of car reports; a table of synonyms of parts of cars known by different names; table showing the depreciated value of $100 at 6 per cent.; settlement prices for cars destroyed; various tables and useful data, and what to do in

accidents and emergencies. Altogether it is, for those for whom it is intended, a very useful little book, and the work of compilation has been well done.

UNIVERSAL INDEX TO THE WORLD'S TECHNICAL AND SCIENTIFIC LITERATURE. Section I, Nos. 1, 2 and 3, and Section II, Nos. 1, 2 and 3. Leipzig: Heinrich Wien, Editor. Each number 16 pp. 8¼ × 12 in.

A few extracts from the announcement of this publication will give an idea of its general scope, purpose and character. In this the editor says:

"The *Universal Index to the World's Technical and Scientific Literature* will make it its aim to be a faithful and reliable *weekly chronicle* of the entire literature of every branch. It will be provided at the close of every year with a carefully prepared *index of authors and subjects*, so that the annual volumes will, in course of time, form an indispensable work of reference for every library.

"The *Universal Index* deals at the outset with the following departments:

"Section I.—1. Architecture, Building Trade and Building Industry. 2. Engineering. 3. Technics, Machines and Appliances and Engineering Industry. 4. Electro-technical Science and Industry.

"Section II.—1. Mining and Metallurgy. 2. Railways. 3. Chemistry and Physics. 4. Chemical Industries. 5. Brewing and Distilling Industries.

"Section III.—1. Iron, Steel and Hardware Industries. 2. Miller's Industry. 3. Paper Industry. 4. Photography. 5. Textile Industry. 6. Sugar Industry.

"As a rule, we propose, in the first place, to take note of the *original articles* published in the journals, but we shall also register the smallest communication, if only it appears to us to possess any special *professional interest*.

"The 'New Books' noticed in the *Universal Index* will be found united in one group for all the divisions of a section. This will cause no difficulty or inconvenience to the professional man. Our attention will be directed not only to the new books published from week to week, but above all to *works still in the press*, so that a reader of the *Universal Index* will always be able to order any interesting work without delay."

The editor adds still further that, "in course of time the *Universal Index* will deal successively with every existing department in the same manner."

This seems a little like the scheme of one of Bulwer's characters, who was engaged in writing "a history of human error."

As far as the work before us has gone, it can, however, be very highly commended. The title of the publication and of each article indexed are given in the language in which they were originally written, and the columns thus have a sort of polyglot character. As an example of the way the work is done, we may select from the matter given in Section I, Part 1, under the head "Engineering," where substantially the index which was published on the front page of the cover of the AMERICAN ENGINEER AND RAILROAD JOURNAL for June, of this year, is reprinted under that title as a sub-heading. Just preceding this are similar titles taken from the *Revista Minera Metallurgica y de Ingeneria*, of Madrid, all printed in Spanish.

Owing to the enormous growth of technical literature, some systematic method of indexing it is becoming daily more essential, and probably one of the greatest assistants in acquiring knowledge in the future will be good indexes.

The editor says that in order to bring the *Universal Index* within the reach of all, the price of the section (II) now ready has been fixed at 3 marks per quarter. It should be added that it is intended to publish it weekly, and that the editor, whose address is given above, appears also to be the publisher.

AERIAL NAVIGATION. By J. G. W. Fijnje Van Salverda, late Administrator of Public Works of the Netherlands. Translated from the Dutch by George E. Waring, Jr. With notes concerning some recent development in the art. Illustrated. 12mo, cloth, $1.25. D. Appleton & Co.

It is interesting to note that a number of well-known engineers, whose past career has given evidence of soberness and soundness in judgment, are now turning their attention to the problem of aerial navigation.

We have lately published a book upon "Progress in Flying Machines," by Mr. O. Chanute, past President of the American Society of Civil Engineers, and now we have for review a book upon "Aerial Navigation," by Mr. Fijnje Van Salverda, which has been translated from the Dutch by that well-known and distinguished American sanitary engineer, Mr. George E. Waring, Jr., who says of his author that he is "a most distinguished Dutch engineer, of advanced age, and now retired from the public service, in which he held the highest position."

The book comprises some 200 pages and an index, and consists chiefly of an investigation of the probable success in the free navigation of the air. It is necessarily somewhat indefinite as treating of an achievement which is merely *in passe*, but it is well worth reading by engineers.

The author begins by giving an account of what has been accomplished with balloons. He devotes his first chapter to a consideration of The Military Importance of Aerial Navigation, and treats of both captive globular balloons for observation and of elongated free balloons for reconnoissance over the enemy's lines. He shows that with the latter a speed of some 14 miles per hour has been obtained by the French, and that, with certain improvements, a velocity of 28 miles an hour is not improbable. This, of course, is in still air; but a table of wind velocities is given as observed at Châlon by means of a self-registering anemometer placed at the top of a mast 90 ft. high, from which it appears that with the above speed the free navigation of the air will be practicable for 50 to 70 per cent. of the days in the year. He does not, however, indicate the formulæ by which the speeds may be calculated for various shapes of balloons or for various horse-powers, nor the probable commercial uses of navigable balloons, but he reaches the conclusion that "the magnificent aim of navigating the air with balloons may not yet be reached, because they cannot be propelled with sufficient velocity to meet all conditions of wind."

Mr. Fijnje, therefore, next turns his attention to dynamic flying machines heavier than the air which they displace, and devotes several chapters to the flight of birds and its various phases—rowing, gliding * and sailing. These are discussed, as well as the changes which occur in the position of the center of pressure under the wings of birds (law of Avanzini), and after two brief chapters upon The Exertion of Force by Birds, and Atmospheric Currents, a discussion is entered upon of the various appliances—the screw, the beating wing and the aeroplane—with which man has endeavored to imitate the birds. From this discussion the inference is drawn that the aeroplane offers the best chance of success, and the author observes, "that rapid travel in the free air need encounter no serious difficulty!"

The remainder of the book consists in extracts from a later pamphlet by Mr. Fijnje, reviewing the experiments in aerodynamics of Professor S. P. Langley, which are held to be in remarkable agreement with the former conclusions of the author; in an account of the article of Mr. Maxim in the *Cosmopolitan Magazine*, and full extracts from the article of Mr. Hallam in the same magazine, as well as of a subsequent article by the same writer in *Cassier's Magazine*.

The concluding chapter is upon The Soaring of Birds and of Men, as suggested by the paper of Professor Langley on The Internal Work of the Wind, read at the Conference on Aerial Navigation at Chicago, in August, 1893, which has been published and discussed in AERONAUTICS.

The book is written throughout in popular style, with few or no formulæ and calculations, and is chiefly valuable as indicating the probability of success from the standpoint of an experienced engineer. There is no reference to the experiments of Lilienthal, or to those of his predecessors in soaring flight, and it is to be hoped that with the new material accumulated within the past year we shall be favored with another book by the author.

POCKET PRIMER OF AIR-BRAKE INSTRUCTION. By W. S. Rogers, M.E., Air-Brake Instructor Delaware & Hudson Canal Company. 90 pp., 4¼ × 6 in.

DISEASES OF THE AIR BRAKE SYSTEM, *their Causes, Symptoms and Cure*. By Paul Synnestvedt. 114 pp., 5¼ × 7¼ in.

That the construction and operation of the air brake is not easy to understand is indicated by the number and character of the attempts to explain it. The first of the books mentioned above belongs to the so-called class of "practical" technical literature, one of the characteristics of which generally is more or less shaky English and incomprehensible explanation. As examples we may quote from page 7. The first lesson opens with this statement: "The foundation principle

* This chapter is entitled "Hovering Flight;" but this is a misnomer, as hovering implies hanging over.

of the Westinghouse automatic air brake is compressed air equalized, reduced or increased on opposite sides of pistons. . . . A homely definition of compressed air is, free air *hammered into hard but elastic shape.*" On the second page of the first lesson, in explanation of the storage of compressed air, it is said: "It is neccessary that we do not confound 'capacity' with 'cubical contents.' A freight car might have a capacity for 4,000 cub. ft. of hay, but if it were only half filled the cubical contents would only be 2,000, while the capacity would still remain." If the writer had looked in a dictionary he would have found that the geometrical meaning of "content" is "area, or quantity of space contained within certain limits," and in that sense has the same meaning as "capacity." We can say with equal propriety that the capacity of tank, or that its content, is so many cubic feet.

A number of what are called "key charts" are given in the book to explain the principles of the brake. These illustrate what a hold the symbolical or emblematical method of exposition has on minds unaccustomed to habits of sustained thought. To such people an emblem seems to act like a mental balancing pole to an unskillful acrobat on a tight rope. If you speak of eternity to such people it does not seem to convey any very definite impression, but if you symbolize it with a circle, and represent hope by an anchor and meekness by a lamb, they will construct a whole system of theology on those symbols for a creed, and it may be that to some extent their lives and conduct will be influenced thereby. Following this symbolical method, our author has devised these charts, in which he has used words as symbols with apparently a sort of cabalistic meaning which a person who understands what he is trying to explain can vaguely comprehend; but it is difficult to see how the charts can explain the construction or operation of the brake to a person entirely ignorant of it.

The explanations of the construction of the brake are very inadequate for the purpose, and the engravings are generally "process" work of a poor quality, often without letters of reference on them or other means of identifying the parts referred to in the text. We are never tired of quoting Huxley's observation that "a prerequisite in good exposition is the imagining of methods by which, beginning with conceptions they possess, there may be built up in their minds the conceptions they do not possess." The book under review is an illustration of his further remark that "of constructive imagination as displayed in this sphere, men at large appear to be almost devoid."

The best chapters in the book are those which describe the practical duties of "train preparation," and "instructions to engineers, trainmen and inspectors," and the "rules for testing brakes."

"Diseases of the Air-Brake System" might very appropriately be called the diagnosis of air brakes. The sub-title describes accurately the character of the book, which points out the causes of defects, their symptoms and cure. It describes in very clear language and in a direct way the parts liable to get out of order, what happens to them, and what should be done when this happening takes place. As an example, the opening of the book may be quoted, which is on pumps, and in which it is said:

"The disorders that arise in this pump (Westinghouse 8 in.) may be classed under two general heads:

"1. Trouble in the upper or steam cylinder.

"2. Trouble in the lower or air cylinder.

"The parts in the upper cylinder most liable to derangement are the main valve (7), reversing piston (23), reversing valve (16), reversing valve stem (17) and the reversing valve plate 18."

The numbers refer to corresponding numbers in an engraving, which is a reproduction from the Westinghouse catalogue, and designate the parts referred to in the text. The book all through is a model of clearness and conciseness. All the descriptions are direct and easily understood. There is no attempt made to describe the principles, construction or operation of the brake excepting so far as these are involved in the defects described. The engravings, with a very few exceptions, are excellent. Especial interest attaches to those in the appendix, which represent various diseased organs of the brake and abnormal deposits which have been found in the various intricate parts of the apparatus. The book can be highly commended, and should be in the hands of every person who operates or has the care of air brakes. A slight defect which may be noted is the absence of titles to some of the engravings, which would have made their significance plainer.

The author calls attention to the fact that the book contains illustrations of practically all the devices in common use, and of several different makes, old as well as new. The W. F. Hall Printing Company, of Chicago, are the publishers.

TRADE CATALOGUES.

LUDLOW COUPLER COMPANY, Springfield, O., Manufacturers of the Ludlow Freight and Passenger Central Draft Automatic Couplers. 16 pp., 8 × 5 in.

The purpose of this is apparently to illustrate and describe the Ludlow coupler, which is shown by various engravings; but the publishers have not been very successful in explaining its construction so that a person without any knowledge of it can understand its peculiarities; but perhaps that was not the purpose in having it printed. It is well printed and the engravings are good.

CATALOGUE AND PRICE LIST OF SURVEYING INSTRUMENTS AND DRAWING MATERIALS, ARCHITECTS' AND CIVIL ENGINEERS' SUPPLIES. A. S. Aloe Company, St. Louis. 212 pp., 10 × 6¾ in.

Twenty-one pages of this publication are devoted to drawing materials, 32 to engraving and surveying instruments, and 128 to drawing instruments and materials. The volume is copiously illustrated with engravings of varying degrees of goodness and badness, but generally they are very good. A draftsman who cannot find materials or instruments to suit him in the large assortment so invitingly described in this catalogue must be hard to please. A good index adds much to the value of this catalogue.

BEMENT & Co., Manufacturers of Feed-Pump Governors and Automatic Feed-Water Regulators, Chicago. 10 pp., 3½ × 6 in.

This very small publication is devoted to a description of the Campbell feed-pump governor, which, it is said, is not designed "to maintain automatically a uniform water level in the boiler," but "is an automatic throttle valve for boiler feed-pumps, and will cause the pump to run at a speed which will at all times supply the exact quantity of water required." A perspective view of the device, report of tests and directions for applying it are given.

CATALOGUE OF 1894. The Tainter Company, Stroudsburg, Pa. 47 pp., 8½ × 5½ in.

The opening page of the Tainter Company's pamphlet is a "plea for a better appreciation of the grinding industry." This is succeeded by remarks about prices, values of machines, etc., then practical hints about emery wheels, the uses for which they are adapted, and a classification of them into coarse-hard, medium-hard, medium-soft, etc. Twenty different kinds of machines are then illustrated. These are followed by remarks about emery, emery oil stone, emery knife sharpeners, polishing paste, liquid polish, knife powders, aluminous paint, etc. The last page contains what we do not remember ever seeing in any other similar publication—that is, a bibliography of the publications of this company, which includes six different treatises, papers, and brochures of interest to persons who use emery grinding machinery, and to that still larger class who ought to use it.

NEW PAMPHLET OF HIGH-GRADE HORIZONTAL AND VERTICAL STEAM ENGINES AND STEEL BOILERS, Manufactured by James Leffel & Co., Springfield, O. 32 pp., 5 × 7¾ in.

The frontispiece of this pamphlet is a good wood engraving showing the works of this company. Perspective views of two stationary engines are then shown—one with a bed plate and the other without. These engines have the usual form of frame now generally used, but center cranks—that is, they have crank-shafts which extend both ways from the crank, with a pulley on one end and a fly-wheel, which is also a pulley, on the other end. The frame has two pedestals on each side of the crank, so that the engine is self-contained and is balanced, although the method of balancing is not shown in the engravings.

The arrangement of steam-chest and valve gear is a little peculiar. It should be said that the engines which are represented all have ordinary slide valves. The steam-chests, instead of being on top or on the side of the cylinders, are placed diagonally between those two positions with the valve face inclined. The valve stem is then connected with the eccentric direct by a rod which is inclined, the stem being horizontal. This will probably strike some designers as a kind of mechanical discord, although, as the valve stem is provided with a strong guide, it is hard to see why an eccentric-rod will not work as well in such a position as a connecting-rod does.

Several perspective views are also given of what the manufacturers call their "self-contained, return tubular boiler," which they also say is known as the Cornish return tubular boilers, and are similar to those now generally used on ocean steamers. The outside shell of these is a plain cylinder with

a cylindrical fire-box inside and a smoke-box at one end, and an uptake at the other. The products of combustion pass from the fire-box to the smoke-box, and then through small flues above the fire-box to the uptake and up the chimney. The smoke-box door—and what a locomotive engineer would call its front, but which a stationary man would call the back —is lined with fire brick, so as to prevent the radiation of heat from the products of combustion while they are passing from the fire-box to the tubes.

There are also illustrations of a horizontal engine and boilers combined and detached; a portable engine, and of upright engines and boilers which this company manufactures.

The engravings are good, but have hardly had justice done them in printing.

BOOKS RECEIVED.

Santo Domingo. Bulletin No. 52 of the Bureau of the American Republics. 202 pp., 6 × 8¼ in., with map.

White's Reference Book of Railroad Securities. Compiled from Official Sources. New York: White & Kemble, 62 William Street; London, E. C.: Frederick C. Mathieson & Sons. 496 pp., 4¼ × 6¼ in.

Water or Hydraulic Motors. By Philip R. Björling, Author of "Practical Hand-Book of Pump Construction." London E. C.: E. & F. N. Spon; New York: Spon & Chamberlain. 287 pp., 4¼ × 7 in.

Report of the Proceedings of the Twenty-Seventh Annual Convention of the American Railway Master Mechanics' Association. Held at Saratoga Springs, N. Y., July 18, 19 and 20, 1894. 310 pp., 6 × 9 in.

Text-Book on Roads and Pavements. By Fred. P. Spalding, Assistant Professor of Civil Engineering in Cornell University; Member American Society of Civil Engineers. New York: John Wiley & Sons. 213 pp., 5 × 7¼ in.

New Roads and Road Laws in the United States. By General Roy Stone, Vice-President National League for Good Roads, and U. S. Special Agent and Engineer for Road Engineering, Department of Agriculture. New York: D. Van Nostrand Company. 166 pp., 7½ × 5 in.

Transactions of the American Institute of Mining Engineers. Vol. XXII, 795 pp., and Vol. XXIII, 685 pp., being Parts I and II of the Proceedings, Papers and Discussions of the Chicago Meeting of 1893, Constituting Divisions C and D of the International Engineering Congress.

Manual of the Railroads of the United States for 1894. Showing their route and mileage; stocks, bonds, debt, cost, traffic, earnings, expenses and dividends; their organizations, directors, officers, etc.; with an appendix containing a full analysis of the debts of the United States, the several States and the chief counties, municipalities, etc., of the country. Also statements of street railway and traction companies, miscellaneous corporations, etc. New York: H. V. & H. W. Poor, 44 Broad Street. 1630 pp., 8¼ × 5¼ in.

TESTING GRAPHITE.

To the Editor of The American Engineer and Railroad Journal:

Your note to our letter published in The American Engineer for June is appreciated, and in order to supply the missing link we will simply say that the easiest way to determine the purity of plumbago is to blast it by means of a blowpipe, or to burn out the impurities by means of nitric or sulphuric acids.

Graphite, as you know, is one of the forms of carbon, of which the diamond is its twin brother. When you burn the diamond it all passes off in carbonic acid gas and nothing remains. In burning graphite, if the graphite is quite pure—say 90 per cent. pure—then there will only remain 10 per cent. impurity, and it usually matters little what that impurity is; it is sufficient to know that you had 90 per cent. of carbon or graphite.

We omitted this in our previous letter for the reason that we supposed that such of your readers who had more or less knowledge of chemistry would readily know how to determine the purity of graphite by laboratory tests, and we have no doubt that many of your readers do know quite as well as we ourselves.

Yours respectfully,

Joseph Dixon Crucible Company.

LOCOMOTIVE HISTORY.

We are indebted to the indefatigable investigator into the history of locomotives, Mr. Clement E. Stretton, of Leicester, England, for the following contributions of interesting data relating to the early history of locomotives in this country. As we have taken occasion to remark before, few people at present are aware how large the number of locomotives was that were imported into this country from England in the early days of our railroads.

Editor American Engineer and Railroad Journal:

I have read with great interest the list of locomotives given in your issue for March, p. 133, and have also compared the same with lists, details and drawings in my possession. However, I find the names of several engines which were sent from England to America are not mentioned in the list, p. 133; for instance, R. Stephenson & Co., in 1832, sent an engine named *Maryland* to the Newcastle & Frenchtown Railroad. In 1831 that firm sent an engine, *John Bull*, to the Hudson & Mohawk Road. In 1831 Stephenson & Co. sent the *Stevens* to New York. Another R. Stephenson engine was named *Whistler*. It appears to have been constructed to the order of Captain Whistler.

In 1833 R. Stephenson & Co. built the well-known engine *Edgefield* for the South Carolina Railroad Company. Another engine built by R. Stephenson & Co. seems to have been named the *Boston*, and to have been built to the order of Mr. Jackson. Altogether I have before me the proof that the firm of R. Stephenson & Co. sent no less than 31 locomotive engines to the United States between the years 1828 and 1837.

In the list on p. 133 I observe that in some cases R. Stephenson & Co. are put down as Manchester, and in others Liverpool. Both are wrong, as the works have always been at Newcastle-on-Tyne.

The works of Tayleur & Co. were near Warrington, not Liverpool, as given in one case. I am at a loss to understand the word "Swartwout" as intended for an English firm. The Camden & Amboy No. 1 was, of course, the *John Bull* shown at the Chicago Exhibition, and built by Stephenson in 1831.

D. & I. Burr & Co., given in the list, is evidently a mistake. My information leads me to believe that this was only a firm of agents who acted for the locomotive builders, Messrs. Mather, Dixon & Co., of England.

The makers of the two last engines on the list are given as John Bull; they are, however, two engines built by Stephenson. The Petersburgh Railroad had three engines from Mather, Dixon & Co., one the *New York*, another *Philadelphia*, the third *Petersburgh*. That line also had several engines from Braithwaite & Co. I trust these few details may assist those of your readers who may wish to further investigate the subject.

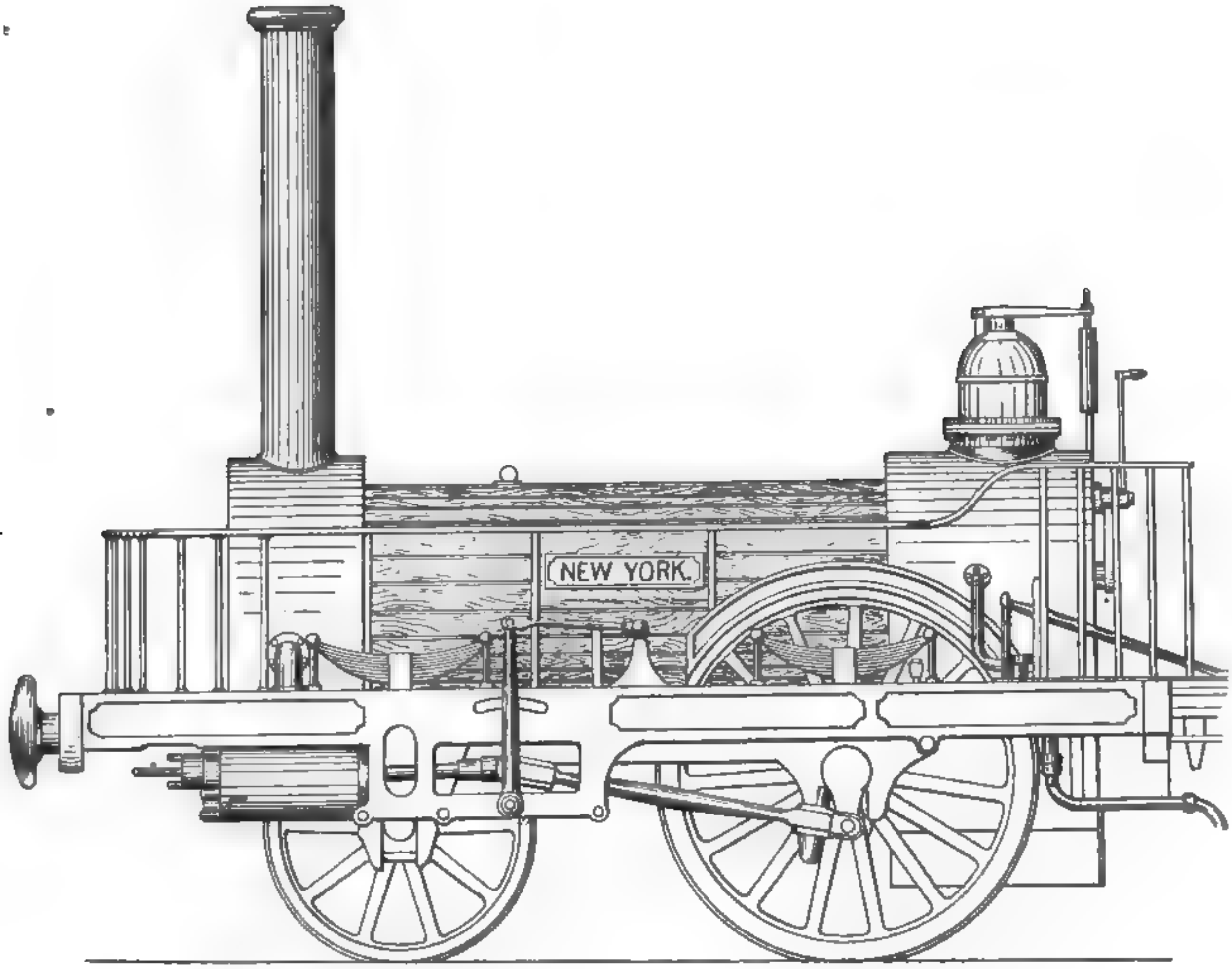
Clement E. Stretton, C.E.

Saxe Coburg House, Leicester, England.

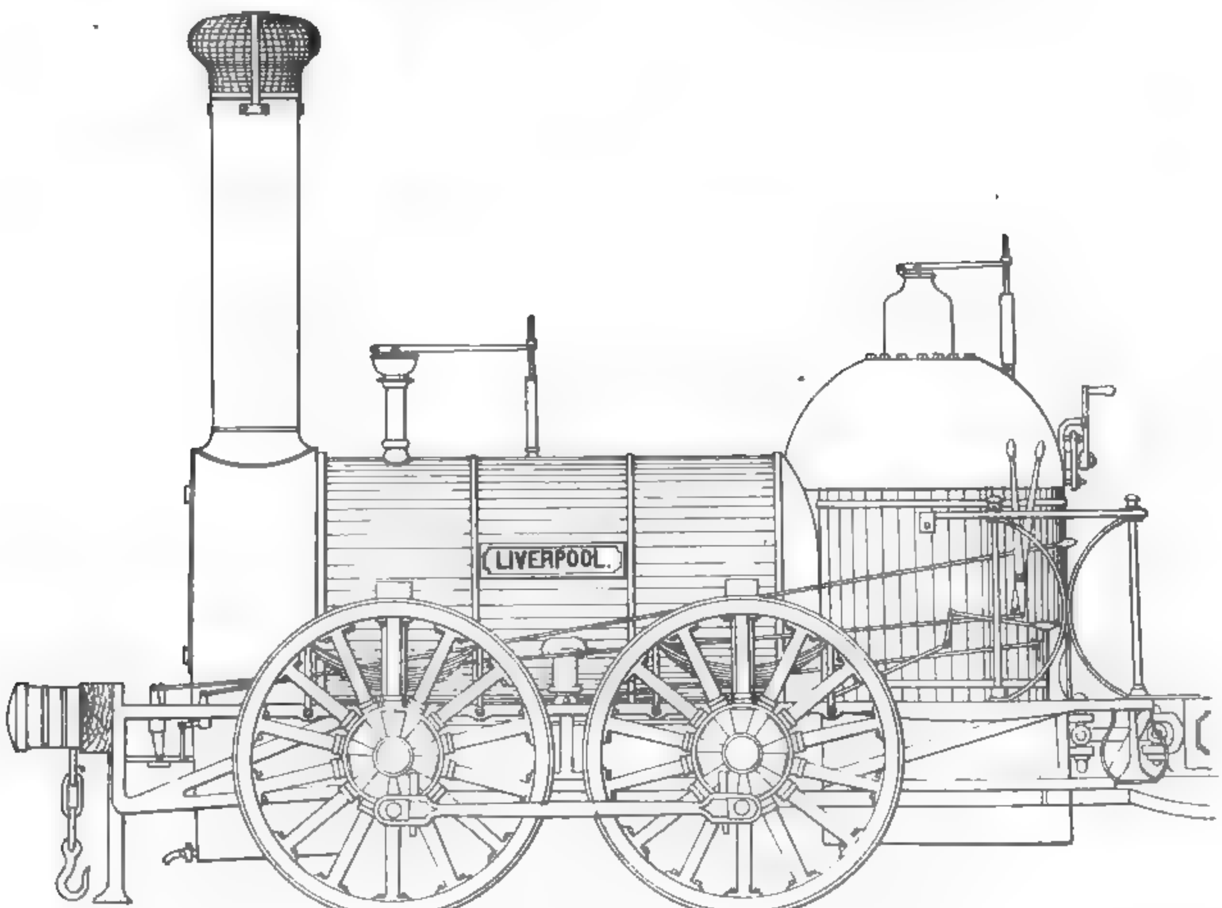
On p. 132 of The American Engineer reference is made to the list given in Wood's book of 1838. If you refer to that list you will find some blanks which I now fill up for your information.

Private makers' numbers, see Wood, 1838.

1828	America	12	Delaware & Hudson Canal.
1828	Whistler	17	" " " "
1828	Delaware	23	Newcastle & Frenchtown.
1828	Boston	27	" " "
1828	Maryland	28	" " "
1828	Pennsylvania	(?)	" " "
1833	"	42	For Saratoga—Bogie Engine.
1833	(?)	52	Not known.
1833	Edgefield	54	South Carolina R.R.
1833	"	60	Mohawk & Hudson.
1833	"	61	" " "
1833	"	75	" " " Bogie.
1834	W. Aiken	87	Columbia R.R.
1834	Howe	103	South Carolina.
1834	"	104	Pennsylvania R.R.
1834	"	105	" "
1834	"	106	Columbia R.R.
1835	Kentucky	110	Not certain for which road.
1835	John Bull	112	Not certain for which road.
1835	Atlantic	113	Not certain for which road.
1835	Sumter	114	South Carolina—Bogie Engine.
1835	Marion	115	" " " "
1836	Ohio	116	" " " "
1836	"	117	Not known which road.
1836	"	120	" " " "
1836	Wayne	125	" " " "
1836	Nash	126	" " " "
1836	"	129	Lexington.
1836	"	139	"
1837	"	151	Baltimore & Susquehanna.
1837	"	152	" " "



LOCOMOTIVE "NEW YORK." BUILT IN 1834 FOR THE PETERSBURGH RAILROAD, BY MATHER, DIXON & CO.



LOCOMOTIVE "LIVERPOOL." BUILT IN 1831 FOR THE PETERSBURGH RAILROAD, BY EDWARD BURY & CO

Total, 31 engines sent to America by R. Stephenson & Co. between 1828 and 1837.

With reference to my letter of the 18th, I was in Liverpool yesterday and saw a member of the Forester family, and obtained from him a blue print of *New York* sent to your country in 1834. I also send print of *Liverpool* sent to Petersburgh Road in 1831.

Yours faithfully,
CLEMENT E. STRETTON.

DESCRIPTION OF LOCOMOTIVE ENGINE "LIVERPOOL," BUILT BY EDWARD BURY & CO., CLARENCE FOUNDRY, ENGLAND, AND SENT TO THE PETERSBURGH RAILROAD COMPANY IN 1831.

Cylinders placed inside under the smoke-box, the piston-rods passing under the leading axle.

Diameter of cylinders		9"
Stroke	1'	6"
Diameter of leading-wheels	4'	6"
" " driving-wheels	4'	6"
Wheels coupled by rods	4'	
Wheel-base	5'	
Front of buffer-beam to smoke-box	1'	7"
" " " " back of smoke box	3'	5"
" " " " leading-wheel center	4'	6"
" " " " driving-wheel center	9'	6"
" " " " front of firebox casing	10'	8"
" " " " back " " "	14'	2"
" " " " " " frame	15'	5"
Boiler barrel, diameter	3'	
" " length	6'	9"
Length of dome casing	4'	
" " fire-box casing	3'	6"
Height of frame from rails	3'	
Rails to center line of boiler	4'	8"

The *Liverpool*, when working on the Petersburgh Railroad, weighed 11,200 lbs., and had a boiler pressure of 50 lbs. of steam.

In November, 1838, this engine drew 15 wagons and one passenger car at 15 miles an hour on a level, and went up a grade of 30 ft. to the mile at from 8 to 10 miles an hour, stopping and starting on the grade.

The weight of freight and passengers carried was 83,620 lbs.; of the wagons and car and engine, 67,500 lbs.; total, 151,120 lbs., or nearly 62½ tons of 2,240 lbs., or 75½ tons of 2,000 lbs.

The above is an exact copy of the dimensions found in possession of the Bury family.

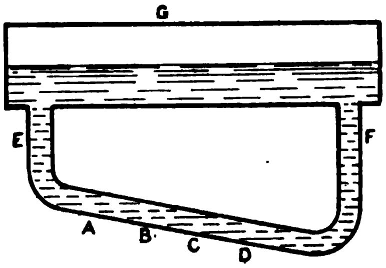
WATER-TUBE BOILERS.

Editor AMERICAN ENGINEER AND RAILROAD JOURNAL:

Despite the antagonistic feelings that at present prevail against boilers of this type, they are becoming more popular every day; the chief causes of their disapproval have so far been owing to their improper construction and management, but these features are being steadily overcome, and what proves to be a stumbling-block to-day becomes a stepping-stone for the morrow. Numerous misleading and absurd theories are advanced to cover up the deficiencies of each new type that is brought before the public, but these are soon exploded under the practical tests to which they are subjected, and in due time pass into obscurity, while the boiler struggles along for an existence, but finally has to yield to an untimely death by corrosion, and is hurried to the scrap-pile.

The subject of circulation has been discussed and reviewed by many theoretical engineers, and the movements of the water in the boiler followed with mathematical precision in space and velocity, until it seems to the would-be inventor that the theory advanced was a sure thing, and forthwith attempts to put it into practical operation. Having built his boiler on the lines of theoretical circulation, he finds on testing that he is as far from the desired goal, as far as practicability is concerned, as when he started. These expensive experiments generally result in disgust and condemnation of all water-tube boilers, and a return to the old familiar shell pattern with all its faults.

In order to produce steam economically it would be necessary to reverse the process as found in the tubular boiler—viz., to cut up the water spaces (as water is a poor conductor of heat) and enlarge the fire spaces, for by dividing the flames and gases combustion ceases and a waste of fuel is the result. This feature of cutting up the water spaces has been overdone in most of the tubulous boilers now on the market. If we take a tube, say, 16 ft. long and 8 in. diameter, and connect it to a steam drum, as shown in the cut, by applying intense heat (as in forced firing) along the parts *a b c d*, the steam generated at *a* would not have time to reach the steam space before the steam at *b* would have overtaken it, and so on all along the tube, which would result in a tube full of steam, and under the intense fire would become superheated, and in order to escape would force both ways, so that the water in the tube would be driven into the steam space until the steam in the tube was liberated. While this action was taking place, although probably but a brief space of time, the part of the tube subjected to the fire would become overheated, and the water coming back upon it would be converted into steam almost instantaneously, and the same action of water lifting would be repeated. The tube under these changing temperatures would be subjected to severe strains of contraction and expansion, resulting in crystallization and corrosion, the proof of which has been fully demonstrated by the short lives of the water tube boilers that have come and gone, and unless the tubes are shortened, allowing the steam quick liberation to the steam space, these troubles may be looked for. In cases where the design calls for long tubes in its construction or a continued, tortuous travel of the steam, they must be of sufficient diameter, so that the water may take up the heat applied, but it will be seen that very little economy would be gained in doing so, owing to the large water spaces and forced circulation.



It is a well-known fact that as soon as steam is formed the sediments are thrown down, and if there is no water in the tube to hold them in solution they adhere to the tube, and by rapid accumulation scale is formed. On examination it will be found in all water-tube boilers that the deposit of scale is greater where the most heat is applied. The recent discussion at the meeting of the American Society of Mechanical Engineers brought to light a great many defects in this type of boiler that have heretofore been kept silent, or their defects covered up by nonsensical theories which are generally swallowed by the less practical purchaser, to whom it often proves an expensive dose when it comes to the practical application of these theories.

The safety of this type is a very important feature to be considered in its favor, when we look over the long list of disastrous boiler explosions which take place every year, resulting in loss of life and property.

The requirements of a practical working water-tube boiler, according to my idea, would be one that shall have short tubes so arranged as to give a natural circulation; quick delivery of steam, unimpeded in its ascent to the steam space; a sufficient body of water at all times to keep the tubes supplied; a large steam space, as this is of vital importance to this type of boiler; light in weight, covering small floor space; and, above all, one that shall be easy to repair when repairs are necessary. For a boiler of this description there is a vast field to be covered, and such a one would sweep away the objections that at present exist, and prove beyond a doubt that the water-tube boilers are in every respect superior to the shell type. Who will bring them to the front? C. T. C.

NOTES AND NEWS.

Railway Accidents in Great Britain.—The government Board of Trade has issued a report giving the number of employés killed and injured during the years 1870, 1873, 1877, 1880 and thereafter to 1892. The smallest number of deaths and injuries occurred in 1870, when 115 deaths and 129 injuries were reported. The last year with which the report deals—that is, 1892—there were 534 killed and 2,215 injured. The proportion of killed to employed was 1 in 714, and of injured to employed 1 in 120.

Gun Work Rejected.—As a result of the recent armor-plate exposures the officers appointed to inspect material for the Navy have been doubly alert, and it now transpires that 29 sets of gun forgings made by the Midvale Steel Company have been rejected. In the forgings the inspectors at the Washington Navy Yard detected a number of fine hair cracks, all in 8-in.

gun work. In many cases the cracks were so fine that the use of a glass was necessary to detect them. The matter was reported to the Ordnance Bureau, and Captain Sampson determined to reject the entire lot, holding that with the tremendous pressure to which the guns are subjected it would be dangerous to put them in use. The company appealed from the decision, but the Board appointed to reinspect the work found that while the hair cracks did not extend for more than an inch or two, in some instances it was discovered by cutting into the material that frequently where one crack would end another would begin. The conclusion reached, therefore, was that the material, for some reason not known to the company or to the experts, was not of the high quality which is required by the contract, and which the company has hitherto turned out. The company will be required to furnish 29 extra sets of forgings, amounting in value to about $50,000.

Compressed Air in a Coal Mine.—In the great Nottingham Colliery of the Lehigh & Wilkesbarre Coal Company at Plymouth, Pa., compressed air is practically utilized for operating the drainage pumps. The Nottingham Colliery is located in the west side of the north branch of the Susquehanna River. The mine is operated by a shaft 365 ft. deep from the surface to the bottom landing, and the workings are extended deeper into the basin by underground slopes of comparatively light pitch. A portion of the workings extend under the river, and this fact, in connection with the location of the major portion of the workings under the low ground of the Wyoming Valley, make necessary the employment of an extensive pumping plant, so as to provide for extraordinary drainage during the wet seasons. Until a few months ago steam was used, but the low pressures available at the pumps, together with the expense of maintaining a safe roof in the passageways through which the steam pipe ran, the liability to accident and interference with the ventilating currents in case the steam pipe was broken, together with a number of other objections to steam, induced the management of the company to adopt compressed air, which fully meets the requirements of the work and the expectations of the company.—*Manufacturers' Gazette.*

Building on Quicksands.—The well-known German engineer, Neukirch, in a paper on making foundations in quicksand, urges that the sand on which the foundation is to rest be converted into solid concrete by blowing into it, by air pressure, powdered dry hydraulic cement, using for this purpose a 1½-in. pipe drawn to a point at its lower end and having three or more ⅛-in. holes. In practice this pipe is joined at its upper end by a rubber tube to an injector, which is connected to a source of compressed air and is fed with dry cement, the sinking of the pipe to the depth required being facilitated by blowing air through it during its descent and setting it in motion, a depth reaching to 19 ft. being thus quickly accomplished. After this the cement is fed in and carried into the sand by the air, which, being forced up through the former, insures a thorough mixture with the cement, and the tube is then slowly withdrawn, the supply of cement being continued until it reaches the surface, the concrete formed in this way taking several weeks to harden and requiring some months to attain its full strength. Further, the whole area to be treated is divided into a number of small areas of about 1 sq. ft. each, and, the tube being sunk successively and operated on each of the squares, it is found that the mixture of the sand and cement produced occupies less space than did the sand alone before the operation. This method of operation has been resorted to successfully in coffer-dam construction and sewer work where such had to be laid in quicksand.

Pensions on the Prussian State Railway.—The pensions and indemnities against accidents which are paid by the management of the Prussian State Railway, as provided in law, are comprised in the two following cases:

1. In case of accident resulting in an incapacity to work, the victim is provided with the necessary medicines and medical attendance free of charge, and insurance equivalent to two-thirds of his usual wages is paid to him. During the first three weeks this expense is charged to the sick fund, which is supported by a tax of 3 per cent. of the wages of the men, of which 1 per cent. is paid by the men themselves and the remainder by the company. If the incapacity to work is only partial, the pension is reduced so as to correspond with what the man can earn by his own labor.

2. In case of death the widow of the employé is allowed a pension equal to 20 per cent. of the wages of her husband, and to each of the children until the age of 15 years is reached, a pension amounting to 15 per cent. is given, provided the mother still lives, and 20 per cent. if she is not living. Finally, parents also receive an income equal to 20 per cent. of the workman in case he was their only support. Taken all in all, these pensions cannot exceed 60 per cent. of the wages of the workman.

In 1892 the number of workmen and employés on the Prussian State railways, who paid their premiums in order to take advantage of this law, was 188,958, about equally divided between the operative department and workmen in shops.

Handling Great Weights.—With monster bullets has come the necessity for handling great weights. The engineer officers in charge of the coast defense guns have been confronted with the problem of bringing huge projectiles from the magazine to the breech of the big guns. With shells weighing 1,000 lbs. apiece, such as the projectiles for the 12-in. rifles, the employment of mechanical power for their speedy handling is obvious. Special facilities also had to be resorted to in the transportation of the powder. Colonel Gillespie, in charge of the coast defense at New York Harbor, is carrying out a plan for the necessary conveniences at the gun-lift battery in New York Harbor, where are mounted two 12 in. high-power breech-loading rifled guns. A 36-in. gauge track runs from the wharf through the entrance of the battery to a transverse gallery connecting the magazine passageways, where a turntable is placed, from which a track leads, right and left, to points opposite the entrance to the magazine passage. There are other connections and another turntable, so that by the system the ammunition loaded upon flat cars from a lighter at the wharf may be delivered at the entrance to the magazine passages. There it will be transferred to the ammunition car by an overhead trolley and hoist of 2,000 lbs. capacity. The transfer completed, the car can be run directly into the magazines. The latter, designed for the storage of shells, are provided with an overhead traveling bridge, trolley and hoist, so that one man can handle a load of 2,000 lbs. at any point of the magazine. The combined ammunition carriage and loading tray, forming part of the gun lift, can, by the same system, be run from its place over the ram of the ammunition hoist into the magazines, receive its powder and projectiles, and have them conveyed to their final position in the gun entirely by mechanical power.—*New York Times.*

Town Refuse as Fuel.—In a recent issue of the *Popular Science Monthly* a description of a Livet furnace which has been set up in Halifax, England, for the purpose of burning town refuse and is successfully working, was given. This furnace appears to depend upon the peculiar construction of its flues, which are so built as to utilize the effect of the decreasing volume of the gases of combustion traveling toward the chimney, thus promoting a high velocity to the air passing through the furnace bars and producing rapid combustion with intense heat. At the same time, the effect of this peculiarity of construction is to cause the gases themselves to move slowly through the flues, so that they may part with their useful heat before escaping into the atmosphere. The force of the draft at the furnace is such that a high and constant temperature is obtained and efficiency of combustion insured, while all unpleasant odors inherent in town garbage are destroyed. As an example of the heat economy effected, it is said that whereas in previous generators the best results ever obtained have been ¾ lb. of water evaporated on the combusion of 1 lb. of refuse, in the Livet generator over 3 lbs. of water are evaporated into steam for every pound of refuse consumed, in spite of the fact that it is frequently known to contain 20 per cent. of moisture. The temperature of the gases just before entering the chimney is stated to be from 300° to 400° F. lower than hitherto obtained. The progression of the gases is partially arrested at both ends of each flue for the purpose of permitting them to deposit the contained light dust in suitable expansion chambers or pits which can be cleaned out when desirable. This arrangement serves to overcome the objectionable dust, which in ordinary "destructors" tends to choke the flues and impregnate the air of the surrounding districts.

Canal Boat Resistance.—The resistance of canal boats to traction has been investigated for the Ministry of Public Works of France by M. de Mas, the account of the experiments being given in a two-volume report issued recently by the Ministry. It was found that at a speed of 3.28 ft. a second the resistance of the 70 odd types of barges ranged anywhere from 3 to 8 lbs. per square foot of immersed section. If the resistance at a speed of 5 ft. a second with a draft of 3.28 ft. (1 meter) is called unity, the resistance with a depth of 4.27 ft. (1.3 meters) becomes 1.13, and with a draft of 5.25 ft. (1.6 meters) becomes 1 27—that is to say, the resistance does increase with the displacement of the boat, but more slowly. Another fact found out was that the resistance may be much reduced by using smooth surfaces below the water-line, the total resistance of a wooden barge being diminished from 782 lbs. to 551 lbs. by covering the sides with oilcloth. The length of the boat was found to have little influence on the traction

when the speed was 5 ft. or more a second, but the form of bow and stern was shown to be important, a spoon shaped bow giving the best results. It is probable that similar tests of resistances will necessarily be made to boats on the American canals as soon as electrical traction has obtained a firm hold, as it undoubtedly will. The present form of canal boat bow is one that is anything but well adapted to a clean and easy movement through the water. There are a few vessels on the Great Lakes which are built in nearly this form, and when they are being forced through the water at a speed of from 8 to 9 miles an hour the wave which banks up in front of them is like the swell following such fast steamers as the *Sandy Hook* and *Monmouth*, running in New York Harbor, with the difference that instead of a smooth, flowing curve, it rises in front like a solid resisting wall. The same may be seen in front of the bows of many steam-propelled canal boats. As long as the mule was the motive power of the canal, and the owner and captain ignorant of the loss by resistance and the speed, there was no probability of any investigation being made; but as soon as large corporations take the matter of propulsion in hand, the labor-saving spirit will prevail, and the most economical forms be adopted as a result.

New Small Arm for the Navy.—The great powers of Europe are almost as deeply interested as is the United States in the competitive tests of small arms begun at Newport Naval Torpedo Station on August 1, where the final step is being taken toward equipping the marines and bluejackets of this country with the most destructive weapon in the world. The small arm at present used in the navy is the familiar .45 in. caliber, which, with the regulation black powder, gives an effective range of 1,200 yds., only 55 rounds being carried per man. With the high-velocity-producing smokeless powder, these guns are rapidly becoming obsolete, and all modern nations have adopted new weapons with smaller calibers. Italy, Roumania and Holland have chosen 6.5 millimeters; Spain and Chili, 7 millimeters; the new United States Army caliber is .30 in.; the famous Lebel of the French is 8 millimeters or .315 in.; the Mannlicher of Germany is 6.5 millimeters; and the ordnance sharps of the United States Navy, after careful consideration, have adopted a caliber of 6 millimeters, or .256 in., the smallest bore used in warfare, being but slightly greater than the familiar .22 in. caliber of the small boy's first pistol or the "cat" rifle.

However, the cartridge the Navy will use in the new gun is totally different from the popular bullet cap. Its projectile looks like an inch and a half of heavy telegraph wire, and the explosive chamber of the cartridge widens out like a champagne bottle. The bullet is nickel steel, coated with nickel, weighing 135 grains; the explosive is 40 grains of rifleite—the highest power of smokeless explosive—the effective or killing range is 2,000 yds., and each man can carry 150 rounds. The United States arsenals have already manufactured a large number of the new barrels, which are but 30-in. long, and the long projectiles from them have been driven through 30 in. of solid pine. Thorough tests have demonstrated the wisdom of adopting the smaller caliber; and the only thing that now remains to provide American bluejackets with the most terrible life destroyers is a breech mechanism enabling the accurate discharge of the greatest number of projectiles in the least time.

Naval officials have the highest confidence in the ability of American ingenuity to supply this desideratum, and with this in view last March Secretary Herbert called upon inventors for a breech mechanism, offering to furnish the new barrels for experimental purposes, and naming August 1 as the date upon which completed guns should be submitted, and tests under a competent Naval Board should commence at Newport. The Government is now ready to begin these tests. It has furnished 27 barrels, many of them to famous gun-makers, and much curiosity exists as to the contrivances submitted. The first order for the new guns—all barrels being made by the Government and the weapon to be finished by the successful inventor—will probably amount to 15,000 arms. It is confidently expected that some radical improvements in small-arm practice will be developed, and little or no doubt is expressed that the United States will secure something superior to anything in use in Europe, if indeed an advance is not made which will astonish the world as much as early great American inventions.

The tests at Newport are exceptionally severe—safety, general action, defective ammunition, excessive charges, rapidity, accuracy, and ability to stand dust and rust entering into consideration. The endurance test will be 500 continuous rounds without cleaning, and the facility with which the breech mechanism and magazine system can be completely taken apart and put together will be noted.

It is understood that upon the result of these trials will depend whether France will abandon the wonderful Lebel arm, with which she has gone to such enormous expense in equipping her troops, and follow the lead of the United States in adopting the smaller caliber and a superior magazine arm. The tests of machine guns which have been going on at the Washington Ordnance Factory and Indian Head Proving Grounds were undertaken with the purpose of selecting the best machine gun mechanism for the newly adopted barrel.—*New York Sun.*

Freight Locomotives in Germany and England.—During the past year some new freight locomotives have been built in Germany and England which are especially interesting in that they indicate the complete deviation from the ideas which have prevailed for a long time in these two countries regarding engines of these types. They are engines of eight wheels coupled. We mention first the engines built at the shops of the London & Northwestern Railway, at Crewe, for coal trains running over this line, and which were constructed in accordance with the designs of Mr. F. W. Webb. The axles, which are four in number, are all coupled together, the last one being back of the fire-box, after the English fashion. This fact, then, with the diameter of the wheels, which is 5 ft. 6 in., causes the distance between the front and back axle to be considerable, amounting to 16 ft. 4 in. the front and back axle having a side play of $\frac{1}{4}$ in. There are three cylinders side by side and all driving the same axle, which is the second one; the central cylinder, which is the low-pressure one, has a diameter of 2 ft. 6 in.; the outside high pressure is 1 ft. 3 in. in diameter, which gives a ratio of volume of 2 to 1. The stroke is 2 ft. for the three cylinders; but the valves of the outside cylinders are operated by the link, while the inside is driven by an eccentric giving a fixed cut-off the same as used by Mr. Webb in his later passenger engines. The boiler works under a pressure of 180 lbs to the square inch; the grate has an area of 20.34 sq. ft. and 210 tubes of $1\frac{1}{4}$ in. diameter, with the length of 13 ft. 4 in. The heating surface of the fire-box is 114.66 ft., that of the tubes 1,372.50 ft., making a total heating surface of 1,487.16 ft. The distribution of the weight on the four axles is somewhat unequal, as we would be led to expect from the general arrangements. The front axle carries 28,000 lbs.; the second, 32,200 lbs.; the third, 28,450, and the last, 21,600 lbs., giving the engine a total weight in working order of about 50 tons. The tractive power of the compound engine can be estimated by taking .50 for the small cylinders, which causes the coefficient of reduction to disappear, since there are two of them giving the formula $p \frac{d^2 l}{D} = 14{,}727$, corresponding to about .15 of the total weight. This coefficient of adhesion is somewhat low for a locomotive with tender, although the English papers which give reports of this engine do not show that any provision has been made for admitting live steam into the large cylinders so as to temporarily increase the tractive power. It is hardly necessary to say that in this model, although there are three cylinders, there is nothing to suggest the type of passenger engines designed by Mr. Webb, in which the cylinders act on different axles in such a way as to get a better distribution of their power. They rather resemble the three-cylinder engines tested by Struve, in Russia, in 1881. It is said that these engines give good results, although no comparative tests as yet have been made between them and engines of the same type, but having only two cylinders, which have been previously built by Mr. Webb for coal service on the London & Northwestern Railway. The Germans have only used engines with six wheels coupled at rare intervals up to the present time. The Baden roads had some built about 20 years ago with eight wheels coupled. Würtemberg roads have had some with ten wheels coupled and flexible connections on the Klose system built within recent years. The Hanoverian Society, formerly the firm of G. Egerstoff, built a locomotive last year which was the 2,500th sent out from this establishment, and which seems to have been built after the American model, as it is, in reality, a consolidation engine—that is to say, it had eight wheels coupled with a pony truck ahead of the cylinders. The coupled wheels were 4 ft. 2 in. in diameter, and the truck wheels 3 ft. 4 in.; the total coupled wheel base 19 ft. 7 in. The steam pressure is 165 lbs. to the square inch; the grate area is 24.75 sq. ft. and the total heating surface is 1,550 sq. ft., with a diameter for the shell of the boiler of 3 ft. 4 in. The fire-box is beneath the back axle, and there is an extension smoke-box. There are two cylinders: one with a high pressure with a diameter of 1 ft. 9 in., and the other low pressure with a diameter of 2 ft. $5\frac{1}{2}$ in., located outside the frames and slightly inclined to the horizontal; the stroke is 2 ft. 1 in. There is a single guide to carry the cross-head, and this is placed above as usual. The valves are inside and controlled

by Allen links. One peculiarity is that this engine is arranged to work at will, either as a compound or simple engine with independent admission and exhaust for the two cylinders. For this purpose it is provided with a non-automatic arrangement after our system, but modified by Mr von Borries: The engine has a steam brake; it has an air screen somewhat extended out toward the front to accommodate the engineer. The weight is 51 tons empty and 58 tons in working order, of which 52 tons are upon the driving-wheels; with the tender filled the total weight is 90 tons; the tractive power of the compound in running order is 18,740 lbs., when working as a simple engine it would be somewhat more than this. Taking 8.6 sq. ft. of heating surface per H.P., the tractive effort which can be obtained at a speed of 9 miles per hour is 17,410 lbs. The pull corresponding to the adhesion at .15 is 17,190 lbs. The engine is intended for running over the tracks with an undulating profile on the Prussian State Railway, while double heading with six-coupled wheels is now required. These engines were ordered by the management of the Hanoverian Railway; but the Right Bank of the Rhine Railway of Cologne have actually tried this articulated compound engine of two axles each, weighing about 56 tons; it has also been done by the State Railway of Baden. They have a little more adhesive weight with a little less total weight, a little more cylinder capacity with the same heating surface as the engines just described. They are very similar, with the exception of the independent tender, to the locomotives of the same system used on the Central Railway of Switzerland. There is, therefore, the means at hand of making an interesting comparison between two types of compound engines of the same power, one with two and the other with four cylinders.—*Revue Générale des Chemins de Fer.*

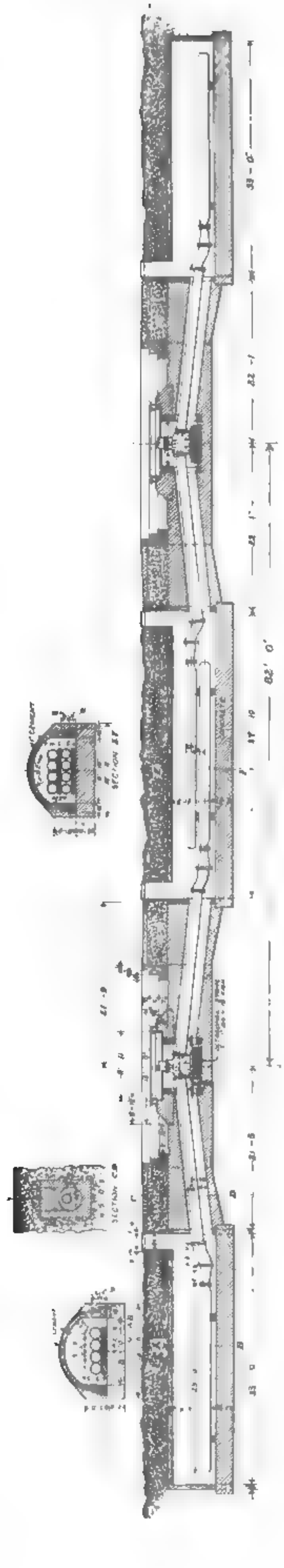
THE PNEUMATIC DYNAMITE GUNS.

Our readers are more or less familiar with the work that has been done and the experiments that have been made with the dynamite cruiser *Vesuvius*, as well as the fact that *El Cid*, afterward the *Nictheroy*, of the Brazilian Navy, was equipped with a pneumatic gun for firing a charge of dynamite. The work that has thus far been accomplished is of such a character as to fully demonstrate the practicability of the pneumatic dynamite gun, both for accuracy of aim and reliability of the expl sion of the charge at the point of impact. In view of these conditions, the Pneumatic Torpedo & Construction Company, of 41 Wall Street, New York, are just completing a battery of three guns for the coast defense at Sandy Hook, N. J., and have the contract for another that is to be located at San Francisco, Cal.

The specifications for the Sandy Hook contract require that the company shall place a battery consisting of one 8 in. and two 15-in. guns, including all of the machinery necessary to fire and handle the same, including carriages and ammunition.

The length of the 8-in. gun is 70 calibers and that of the 15 in. 40 calibers. Our illustrations all refer to the larger gun. The plant includes a complement of boilers, air compressors, storage reservoirs and pumps that will give a capacity for a continuous fire of extreme range of 50 rounds for the first hour, comprising 20 rounds from the 8-in. gun and 30 rounds for the two 15-in. guns, and 30 rounds per hour thereafter. The boilers, which lie at the basis of the whole work, are of the ordinary horizontal return tubular type. They are four in number, each 5 ft. 6 in. in diameter, and 16 ft. long, with one hundred 3-in. tubes. These boilers are fed with both pumps and injectors, either of which is of sufficient capacity for regular working. At present a natural draft is used, with a separate stack for each boiler, but it is probable that after the parapet has been built in front of the guns that these stacks will be removed and a forced draft substituted, as the stacks could be readily shot away, thus seriously crippling the plant. Water is obtained from wells sunk in the sand just outside the building.

The compressors are in duplicate, each one being amply sufficient for the service of the gun as required by the contract. They are what is known as the three-stage compressor, or the reverse in their action to that of a triple-expansion steam engine. Each compressor has two sets of steam cylinders that are 16 in. in diameter, with a stroke of 22 in. One end of the piston-rod makes the usual connections to the crank shaft, while the other extends back through two air cylinders that are placed tandem behind the steam cylinder. Next to the steam cylinder on each side there is one first stage air cylinder. These two cylinders are 14 in in diameter and are connected in parallel, delivering their air into an intercooler located between the first and second cylinders. After leaving the second cylinder the air passes through another intercooler



SECTION THROUGH SUBTERRANEAN FIRING RESERVOIRS FOR DYNAMITE GUNS AT SANDY HOOK, N. J.

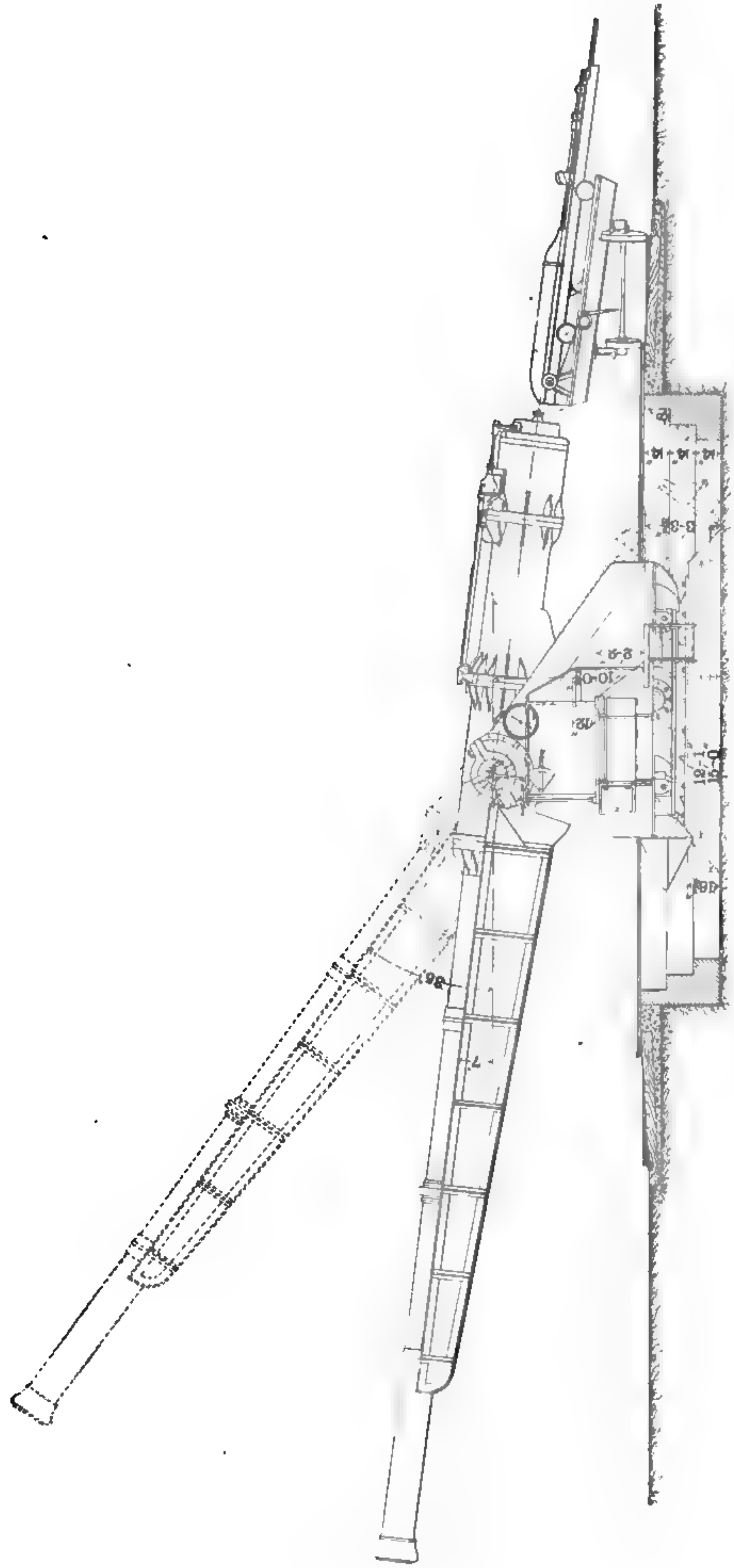
to the third cylinder, wherein it is compressed to the final pressure, which ranges from 1,000 lbs. to 2,000 lbs. per square inch.

When the air leaves this cylinder it passes through an after cooler in order to reduce the heat to which the joints are exposed, thus bringing it down to average atmospheric temperatures. The diameters of the three compressing cylinders are 14 in., 8¼ in. and 4¼ in. respectively for the low, intermediate and high pressures. The air pressure as it leaves the first cylinder is 75 lbs, and 375 lbs. for the second. The compressor plant also includes two duplex pumps with steam cylinders 6 in. in diameter, and water cylinders 5¾ in. in diameter, with a common stroke of 6 in. These are used to circulate water through the coolers and water jackets of the cylinders. Finally, there is a 50 H P. high-speed engine driving a 38-kilo-watt dynamo at a speed of 850 revolutions per minute, and developing a 110-volt current. This current is used for the electric lights about the building and for driving the electric motors on the gun carriages. A slate switchboard in the engine-room contains an ammeter, voltmeter and switches for connecting to the guns. In the engine room above the circulating pumps are the feed-water heaters through which the exhaust steam from the compressor engines and pumps passes, raising the temperature of the feed water to 180°.

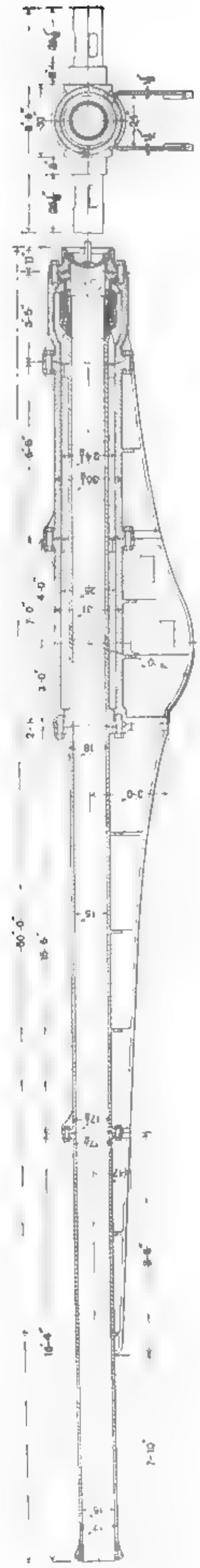
The pressure ordinarily stored in the reservoirs is 2,000 lbs., though it is reduced t. 1,000 lbs. for service in the guns. In the room occupied by the storage reservoirs there is a bank of valves working somewhat on the principle of a gate valve, but modified for the special service which they are to render; for while they are held closed by the pressure upon the back of the valve there is a small

LOADING ONE OF THE DYNAMITE GUNS AT SANDY HOOK WITH A FIVE HUNDRED POUND CHARGE.

(From *Illustrated American.*)



SIDE ELEVATION OF 15-INCH PNEUMATIC DYNAMITE GUN AT SANDY HOOK, N. J.



LONGITUDINAL AND CROSS SECTIONS OF 15-INCH PNEUMATIC DYNAMITE GUN.

supplementary valve that is opened by a slight play in the stem of the main valve, by which the latter is balanced and then easily opened against the great pressure existing in the pipes. These pipes are so led to and from the bank of valves that the compressors can deliver air directly to the gun reservoirs, thus pumping into the guns as it is called, or send to the storage reservoirs at the will of the attendant. It is the duty of this man to see that a pressure of 1,000 lbs. per square inch is maintained in the guns.

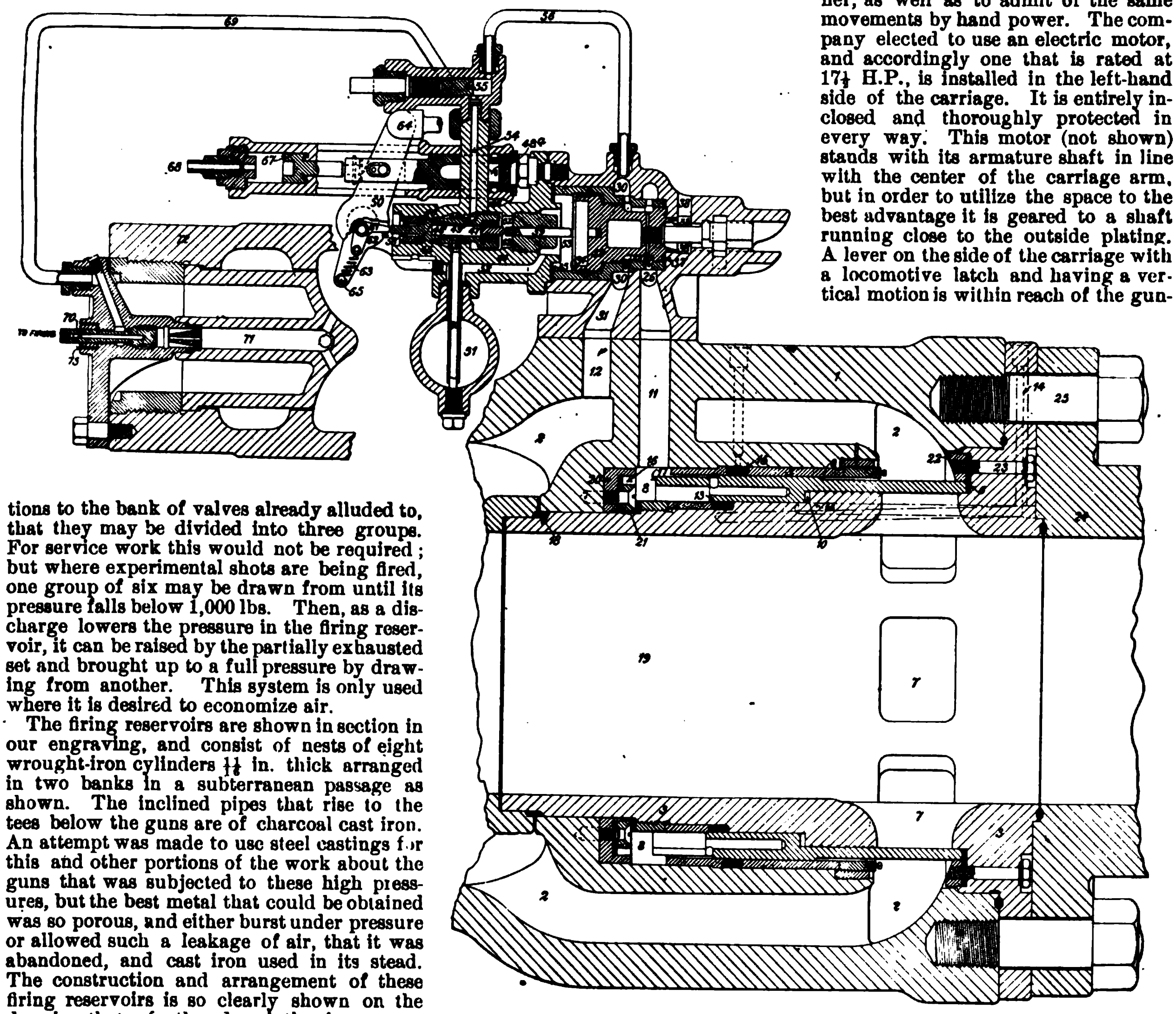
The storage reservoirs have a capacity of 450 cub. ft., and consist of a nest of 18 wrought-iron cylinders each 25 ft. long, 16 in. in diameter, and with shells 11/16 in. thick. The heads are welded in so that there are no rivetted joints about them. These reservoirs are arranged by means of their pipe connections to the bank of valves already alluded to, that they may be divided into three groups. For service work this would not be required; but where experimental shots are being fired, one group of six may be drawn from until its pressure falls below 1,000 lbs. Then, as a discharge lowers the pressure in the firing reservoir, it can be raised by the partially exhausted set and brought up to a full pressure by drawing from another. This system is only used where it is desired to economize air.

The firing reservoirs are shown in section in our engraving, and consist of nests of eight wrought-iron cylinders 11/16 in. thick arranged in two banks in a subterranean passage as shown. The inclined pipes that rise to the tees below the guns are of charcoal cast iron. An attempt was made to use steel castings for this and other portions of the work about the guns that was subjected to these high pressures, but the best metal that could be obtained was so porous, and either burst under pressure or allowed such a leakage of air, that it was abandoned, and cast iron used in its stead. The construction and arrangement of these firing reservoirs is so clearly shown on the drawing that a further description is unnecessary.

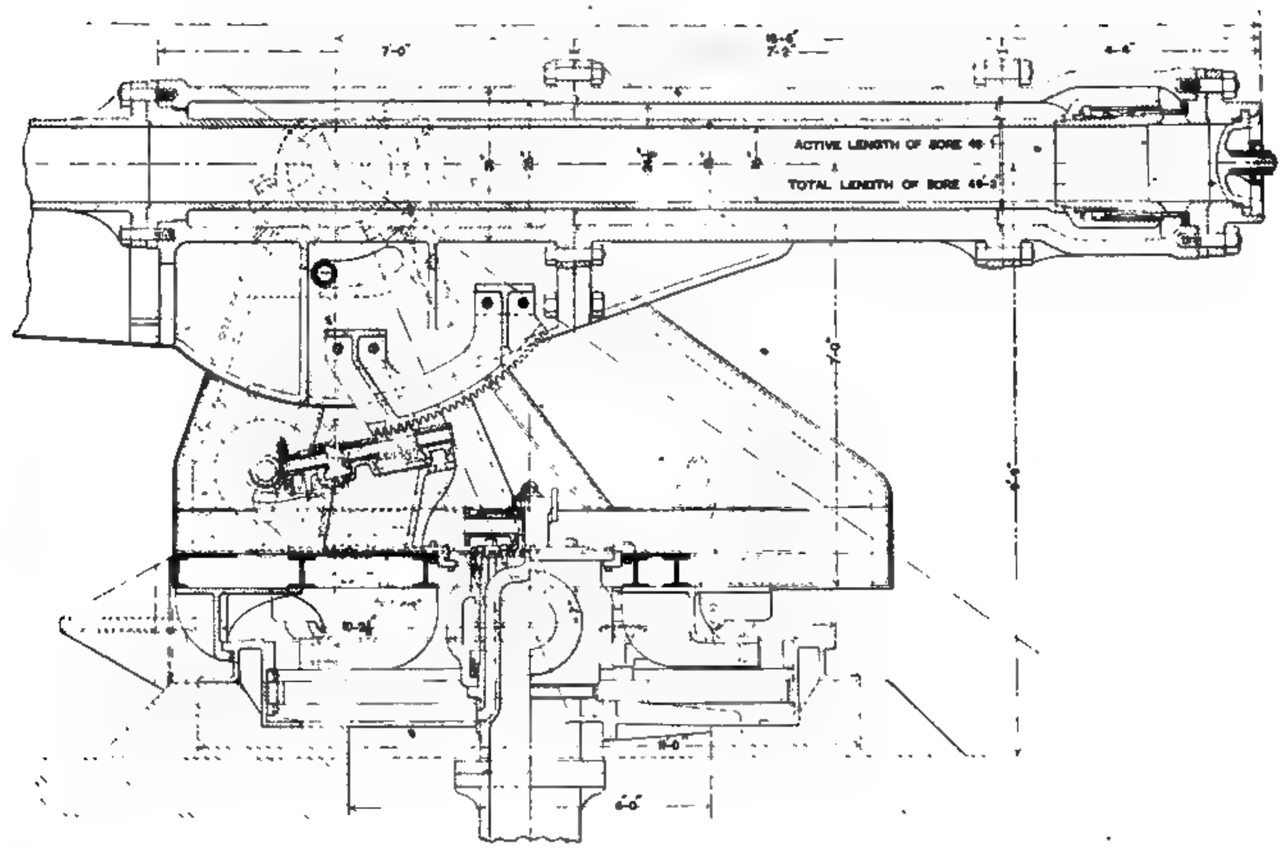
We have now reached the gun, about which the principal interest centers. As it stands it is the result of the work of Captain J. J. Rapieff, Chief Engineer of the company, who has so remodeled the original pneumatic gun that there is really nothing left beyond the bare fundamental principle; so that the ingenious valves and mechanism belonging to the gun and the cartridge are monuments of his skill.

The 15-in. gun has a total length of 40 calibers, or 50 ft. from face of muzzle to the back of the breech block. The trunnions are 35 ft. from the muzzle. The dimensions given on the longitudinal section of the gun show the various thicknesses of metal that are employed. The forward end of the gun is supported by ribs cast on the barrel, and the whole is held together by bolts as shown. Air is admitted to the gun from the firing reservoirs through a vertical connection, whence it passes to the trunnions, entering the annular space about the breech, which is always subjected to the pressure existing in the firing reservoirs with which it is connected. The joints of the trunnion and vertical connections are packed with leather cup packing. These cup packings are held out by an oil pressure from behind that is developed by admitting air under pressure into a cylinder at the right-hand side of the carriage. This cylinder carries a piston that forces a plunger down into an oil chamber, thus materially increasing the hydrostatic pressure of the latter and serving to hold the leather packing tight. Enough oil oozes through the leather of this packing to lubricate the working portions of the gun and preserve it from rust.

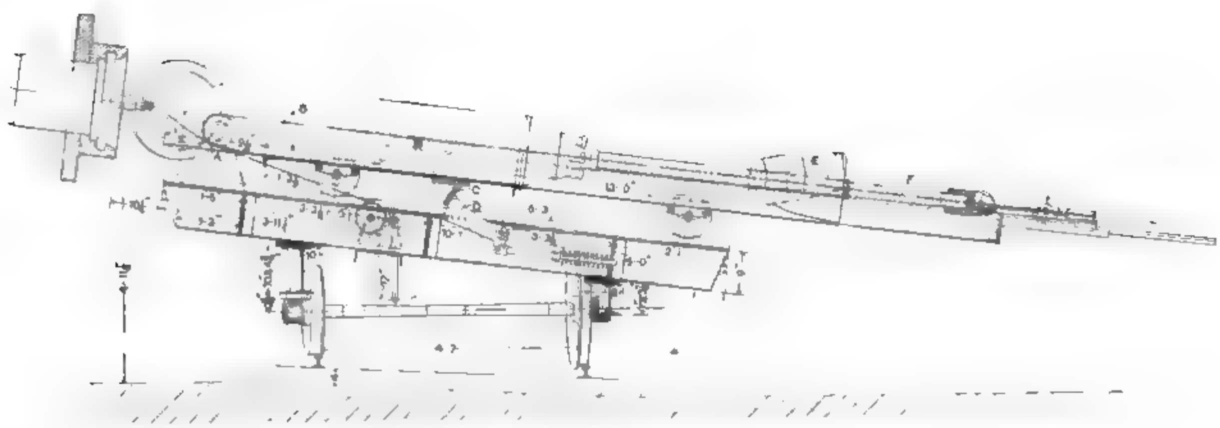
The gun is mounted on a carriage with a center pintle that allows it to traverse through a complete circle. The elevation obtainable is 35°. The specifications required that it should be trained and elevated by pneumatic or hydraulic, or, alternatively, by electric power directly under the control of the gunner, as well as to admit of the same movements by hand power. The company elected to use an electric motor, and accordingly one that is rated at 17½ H.P., is installed in the left-hand side of the carriage. It is entirely inclosed and thoroughly protected in every way. This motor (not shown) stands with its armature shaft in line with the center of the carriage arm, but in order to utilize the space to the best advantage it is geared to a shaft running close to the outside plating. A lever on the side of the carriage with a locomotive latch and having a vertical motion is within reach of the gunner, serves to connect the shaft from the motor with the elevating or training shafts, only one being in gear at once. A handwheel on a vertical shaft located just in front of the railing about the gunner's platform serves to throw the driving mechanism for elevating and training into and out of gear. This is operated by the gunner, who has his eye at the telescope, whose cross wires are to catch the target. The method of working is for the gunner to give the gun the proper elevation and then, throwing in the training gear, he brings the crosswires of his telescope on the target and fires. The connection between the shafts and the gun is by means of a worm working in a segment, as shown in the enlarged section of gun and carriage. The recoil is rigid, and is taken up by the base plate. The carriage is carried by rollers running on a circular track and provided with roller bearings, which has greatly lessened the resistances where the work is done by hand. In order to take violent strains off the rollers the shoes are fitted to the carriage, which have a bare clearance from the inside of the circular track.



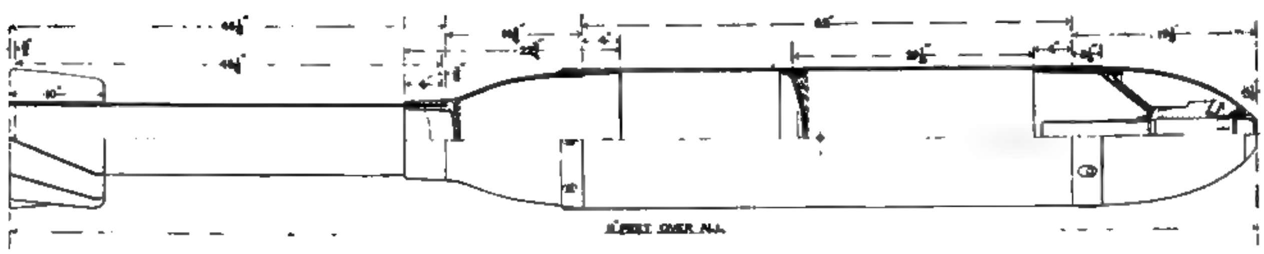
COMBINATION OF AIR VALVES FOR 15-INCH PNEUMATIC DYNAMITE GUN.



BREECH AND CARRIAGE OF 15-INCH PNEUMATIC DYNAMITE GUN.



LOADING CARRIAGE FOR 15-INCH PNEUMATIC DYNAMITE GUN.



500-POUND DYNAMITE SHELL FOR PNEUMATIC GUN.

Thus far we have been dealing with comparatively simple problems in mechanics, but when the work of designing the firing mechanism was approached the difficulties to be surmounted were very great. How well this has been done we leave our readers to judge. Some of the conditions to be fulfilled were that there should be no possibility of a discharge when the breech was open; that the proper quantity of air should be admitted to secure the desired muzzle velocity, and that this quantity should be capable of being varied at will. In the engraving, which shows a section of the valves, the whole combination is grouped together to save space on the drawing, while in reality the parts are separated on the gun. Parts 70–73 are at the trunnion by the gunner's platform; parts 26–68 are at the top and side of the gun just at the junction of the breech to the annular space, as shown on the side elevation, while the remainder is in the breech itself.

Compressed air at 1,000 lbs. pressure having been obtained in the firing reservoirs, the cartridge having been put in the gun and the breech closed and entirely locked, the firing lever may be pulled and the dynamite sent on its errand of destruction. It may be remarked just here that the personal equation is no factor in the operation of the valve, and it is of no moment whether the firing lever is pulled slowly or quickly. This lever is shown on the side elevation extending down from the center of the trunnion. When the gun and firing reservoirs are under air pressure the compressed air has access to the chamber 71, holding the valve on the firing stem against its seat. Pulling the lever unseats this valve and allows the compressed air to rush past it and into the pipe 69. This air enters the chamber 48a and forces the stem and piston connected to the lever 60 to the left. It is here that the interlocking apparatus works. Attached to the lever 60 at the point 64 is a rod running back to a latch on the breech. So long as the breech is tightly locked this latch is free, and the rod leading to 64 can be moved ahead. But as soon as the breech-locking mechanism is started this latch is caught, holding the lever to 64, which in turn prevents the lever 60 from moving, and thus stops all further action of the valve. But if, as we have supposed, the breech is closed and locked, the lever 60 is thrown ahead and the tappet 61, which is pivoted just below the center of the lever fulcrum, is thrown back and strikes the stem of the valve 47, pushing it to the right. As this is done the space 53, passage 52 and ring 44 are put in communication with the air and exhausted. At the same time the ring 49 is filled, air enters the interior through the duct 46, and the pressure in 43 acting on the larger area of the differential piston 48, causes it to jump away from 61 to the right and thus complete the exhaustion of the space 53. The annular space 2 about the breech being filled with compressed air, the latter has access to the back of the differential piston 32, and as the space 53 is exhausted this piston 32 moves to the left, passing beyond the port 27 and opening it to the atmosphere through the escape 38. As up to this time the passage 11 has been in direct communication with the air pressure in the annular space by way of ports 27, 28 and 29, the full pressure has been exerted on the surfaces 17 and 13 of the main valve to hold it against the packing 6 and close the ports 7. But when the air in 11 is exhausted the pressure in 2 acting against the shoulder 9 of the main valve, throwing it to the left and admitting air into the gun. However, as the valve 32 moves to the left, it strikes the stem 59 of the valve 47, driving the latter home to its seat and thus stopping the escape of air from 53, which immediately begins to fill again through the pipe 56 by way of the opening 30 into the annular space, the chamber 55 and the passage 54. As soon as the pressure in 53 has risen sufficiently to overcome the pressure in 30 exerted on the back of the differential piston 32, the latter moves back to the right, cutting off the escape from 11, and re-establishing communication between it and the space 2. Then the pressure in 8 being again exerted on the surfaces 17 and 13, overcomes that on the shoulder 9 and closes the main valve. This may seem a long and tedious process, but in point of fact the actual time required is less than that demanded by the usual primer to ignite a powder charge. The time during which the main valve remains open is regulated at 55, where the flow of air from the pipe 56 to the passage 54 is controlled. So as the time required for the pressure in the space 53 to rise high enough to move the valve 32 back to its normal position is varied, the opening of the main valve is correspondingly lengthened or shortened.

In order to facilitate the loading, the cartridge is placed in a cradle that is carried to the loading carriage. This cradle consists of a trough shaped to fit the cartridge and is carried on four wheels that run on the track of the loading carriage. Back of the trough there is a small trolley with a stem, *F*, extending forward from it that bears against the base of the tail tube. A wire rope is looped over the horizontal wheels at the back of this little trolley, and as it is tightened by winding on the drums shown, the cartridge trough moves forward until the clip *C* rides over by depressing the dog *D* and engages with it. Then the prolongation of the trough *A* has entered the breech and is stopped. As the winding is continued the cartridge is pushed into the gun until the little trolley comes up against the stop *B*, when the cartridge is home. The trough and its carriage is then slacked back, the breech closed, and the gun is ready for firing.

The gun with its firing valves having been designed, the cartridge with its fuse offered a problem for solution that was by no means easy, but one which Captain Rapieff has disposed of. Our engraving shows an elevation and section of the cartridge. The fuse is at the front end, the details of which the company are not quite prepared to make public. Back of the fuse is the chamber for the charge of dynamite, containing a diaphragm for steadying the load, and this is followed by the tail piece carrying wing that gives the proper rotation to the projectile. Back of the wings a gas check is placed. This drops off when the projectile is clear of the muzzle. The front end of the cartridge is so thin as to break on impact with a solid, while the interior arrangements are such as to secure an absolute explosion should the projectile plunge into the water or strike a glancing blow. The fuse is so designed that its action is certain under all conditions; it is absolutely safe from a premature explosion, and detonates its charge upon impact with a solid target either point on or with a glancing blow, and detonates the charge at the end of a given interval of time after entering the water. The fuse is 12 in. long, 3½ in. in diameter, and weighs 20 lbs. To the end of it is attached a brass case containing a priming charge of 2½ lbs. of dry gun cotton. A few grains of fulminate of mercury are used to detonate the dry gun cotton.

It may be well to remark that since the Port Royal tests of the guns on the *Vesuvius* it has been learned that fulminate of mercury, in order to detonate dry gun cotton, must be pure; that chlorate of potash will prevent the work from being done; and as this impurity existed in the fuses used at Port Royal, the results were not what they would be were the experiments to be repeated with the present knowledge on the subject.

SUB-CALIBER PROJECTILE WITH AND WITHOUT RIDERS, FOR 15-INCH PNEUMATIC DYNAMITE GUN.

The specifications for these 15-in. guns require that they shall have a range of 2,000 yds. with a shell containing 500 lbs. of explosive; 3,550 yds. with 200 lbs.; 4,500 yds. with 100 lbs., and 5,500 yds. with 50 lbs. These different charges are, however, not all put in 15-in. shells, but in shells of varying diameters; for, by a system of riders invented by Captain Rapieff, an 8 in. shell can be fired from a 15-in. gun. These are clearly shown in our photo-engraving. The binding wire is taken off when the shell is put in the gun, and the pieces drop off after the projectile is clear of the muzzle, and when these and the gas check shown at the back are gone the shell is clear for flight and destruction.

The time required for loading and firing a 500-lb. shell is limited by contract to 3 minutes, and 10 rounds must be fired in 40 minutes. For the 200-lb. shell the time is 2 minutes, with 10 rounds in 27 minutes, and for smaller shells the time limit is 1½ minutes with 10 rounds in 20 minutes. The time of manœuvring from extreme depression to extreme elevation, or the reverse, must not exceed 15 seconds, and the time of complete traversing 2 minutes.

The guns are now located on the site of the permanent battery on the shore just inside Sandy Hook. They have complete command of the whole southern approach to New York Harbor; the range of their fire extending from beyond the bar, through the Gedney Channel, over the Swash Channel to a point beyond the Romer Shoals beacon, while the Main Ship Channel is directly off the battery with the farther side not more than 1,500 yards from the guns.

THE ECONOMICAL EFFICIENCY OF LOCOMOTIVES AS COMPARED WITH STATIONARY AND MARINE ENGINES.

In a recent paper in the *Revue Générale des Chemins de Fer*, M. Desdouits, engineer in charge of locomotives and rolling stock on the State Railway of France, enters into a very complete and analytical discussion of the relative economical efficiency existing between locomotives and stationary and marine engines. He defines the coefficient of economy of any machine as being the ratio between the work received and the output. The output of a steam-engine can be measured by water or by fuel. It is evident, however, that it is the consumption of fuel which ought to serve as the final measurement of the economical work of a motor; but it is the consumption of water that is taken as a basis in order to do away with the influences exerted by differing types of boiler construction.

The work done is the *effective* work—that is to say, that which is transmitted according to the type of machine to the shaft or driving-axle. It is this work which, in the case of locomotives, we have been in the habit of designating under the name of work at the tire or tractive forces.

In default of the knowledge of the effective work, the economical coefficient is determined for marine engines and for certain stationary engines by measuring the effort exerted upon the pistons, which is obtained by means of the indicator, and which is therefore called the indicated work.

But the measurement of the indicated work will not of itself suffice for the determination of the coefficient of economy. It must be supplemented by a measurement of the passive resistance. The values thus found for the influence of passive resistance vary between 10 and 15 per cent. of the effective work in case of non-condensing engines; they remain as high as 20 per cent. for condensing engines.

In a series of very careful tests, which were made in 1882, M. G. Marié undertook to determine the economical efficiency of an engine with high tractive power. The profile chosen was a heavy grade. This circumstance permitted the exact determination of the effective work, by far the most important portion of which consisted in overcoming the gravity; consequently the uncertainty which exists regarding the value of the rolling coefficient in the total valuation was reduced to a minimum. The results of these tests ought to be considered as being very exact. The consumption of water was found to be 28½ lbs. per effective H.P. The proportion of water entrained was valued at 9 per cent. The corresponding weight of dry steam was 25¼ lbs. The report of the tests did not give the average point of introduction of the steam; according to the conditions of the load and the profile, it may be taken at about 30 per cent.

In the recent experiments on the State Railway, the engines experimented with were of the type known as the two-axle coupled locomotive. The principal dimensions and the construction and operation are as follows:

Diameter of driving-wheels		6′ 6¾″
" " cylinders		1′ 5½″
Stroke of pistons		2′ 1.6″
Volume swept through by piston		8½ cub. ft.
Clearance space		.2 "
Size of ports		9″ × 1′ 3″
Maximum opening of valves	Full opening 70 per cent.	1′
	at 25 per cent admission.	⅜
Outside lap of valves		1.2″
Inside " " "		.12″
Boiler pressure		128 and 142 lbs. per sq. in.

The first series of experiments was made on five engines which hauled the express trains between Paris and Chartres. All the tests were made on an express train between Versailles and Chartres, a run of 44 miles. The composition of the trains and the conditions of running were almost identical.

An examination of the results obtained shows at first glance a very great similarity, one might almost say an identity of economical results furnished by engines of the same construction working under the same conditions of service. It is readily understood, of course, that engines of the same construction and running at the same speed with the same cut-off ought to perform the same amount of useful work for a pound of steam consumed, at least when there was none among them where there was a loss of motor energy such as results from defective throttle-valves, valves or pistons, or from the development of abnormal passive resistances, such as insufficient lubrication, binding of the moving parts or trucks, pounding, etc.

Just here we may cite a comparative test which was made with two engines hauling a very fast train of light weight. One of the two machines was left entirely to the judgment of the driver, who in the easy parts of the line ran with a very short cut-off, or throttled the steam at the throttle-valve. For the second the point of admission was determined in advance as high as 25 per cent. When this admission was found too great for the average traction, the throttle-valve was gradually closed. The comparison of the two results shows that the engine where the cut-off was systematically maintained at a somewhat relatively high point gave practically the same results and perhaps superior to those on express trains with the same point of cut-off. The second engine, on which the cut-off was varied according to the profile of the line, showed a considerable loss of efficiency.

The table accompanying the report of this test shows that the consumption of water per effective H.P. was 29 lbs. where the engineer ran at discretion, and 25.3 lbs. where the minimum point of cut-off was fixed at 25 per cent. of the stroke.

It is clear that to proceed in a really methodical manner, and to obtain an exact comparison between the efficiency of locomotives and those of stationary or marine engines, the corresponding efficiency must be considered with reference to a predetermined speed rather than to the most favorable speed. For stationary and marine engines which are called upon to work regularly under conditions of speed and admission which are almost invariable, it can be admitted that the speed determined upon by the builder and adopted in practice corresponds practically to that of maximum economy; for a locomotive, on the other hand, it is necessary to determine from an average of special experiments the speed where the amount of work done is at a maximum. We will not insist upon this question, but will limit ourselves to recalling that this speed generally corresponds to an admission which varies very slightly from 25 per cent.

In regard to the value of inside lap in determining the efficiency of a locomotive, experiments were made upon an engine which were in every way similar to those which we have under consideration, in which the inside lap was reduced from .10 in. to .02 in. The results of the tests made showed that the engine which had been thus modified was greatly improved, and since the modification was made the engine has constantly stood at the head of the list for economical efficiency.

Accommodation and Freight Engines.—There is no real difference between engines hauling accommodation or mixed trains and freight trains, as far as the method of working steam is concerned, from those of passenger engines. The reduction in the diameter of the wheels is practically compensated for by lessening the running speed, so that the rapidity of the movement of the piston and valve, which is an important factor in effective distribution, remains almost the same. The influence of passive resistance is not *a priori* greater, for the increase of its absolute value corresponds almost exactly to that of the work done upon the pistons. Finally, it may be taken for granted that the absolute amount of work done by these engines is the same as in passenger engines.

From the standpoint of conditions of service, the engines which haul a freight train feel the influence of variations of load and the profile more than a passenger engine. It is compelled on heavy grades to run with a long cut-off, but on slight down grades and even on levels it only utilizes a small amount of its total power. We note, especially at high speeds, that running with a short cut-off is a favorable condition for economical work; for these reasons the freight engines will generally give poorer results in service than passenger engines. Experience shows that the consumption rarely falls below 26½ lbs. per effective H.P., and sometimes rises to as high as 28.7 or 30 9 lbs. These figures have a purely relative character; hence it does not seem worth while to reproduce the results of particular experiments, which are only interesting when they approach the conditions imposed in running.

The Use of Piston-valves.—The use of piston-valves, independently of other advantages which are less clearly demonstrated, secures a reduction in passive resistances which amounts to 5 per cent. of the total strain. There is nothing to prevent the accomplishment, with this system of valves, of those conditions of distribution of steam which are recognized as most advantageous in themselves. It seems, then, that it is possible to show in an engine with piston-valves a marked increase in absolute economy over engines with flat valves. In point of fact, however, this superiority has not yet been clearly shown, at least in high-speed engines. This is principally due to the fact that, in the diagrams of engines with piston-valves, an attempt has been made to gain the advantage of the small clearance spaces, which results, at least at high speeds, in an exaggeration in the compression lines. When these same engines run at an exceptionally low speed, very favorable results can be obtained.

Consumption of Dry Steam per H.P. per Hour.—In all the experiments which we have just cited, the consumption is

given in the gross weight of water which passes from the boiler to the cylinders, which consequently includes all that water which was entrained in a liquid state. No direct experiments have as yet been made in order to determine the correct proportions; all the tests which have been made agree in indicating to us that it is very slight, and probably differs but little from 5 per cent.—a proportion which is lower than that usually attributed to either stationary engines or marine engines. The results generally obtained in the experiments of the State Railways, and which are confirmed by the old drivers on the Eastern Railway as well as those of the Lyons Railway, may be given in *résumé*, as follows: The locomotive in its usual form, with the simple valve distribution, can drop the consumption of water per effective H.P. per hour to less than 24¼ lbs. Under average conditions of service with a passenger engine the consumption ranges from 25¼ to 26¼ lbs. of water, or from 24¼ to 25¼ lbs. of dry steam. The consumption is markedly increased when running with a light load on a favorable line in which an exaggerated amount of expansion is used. The economical results furnished by a locomotive are in their totality notably superior to the most favorable results which have been made either on stationary engines or marine engines provided with the same system of steam distribution. The reason for this superiority is due to:

1. The use of relatively higher steam pressures.

2. The rotative speed being great enough to reduce the effect of cooling of the walls of the cylinder to an insignificant amount, and yet slow enough so as to cause no trouble with the conditions imposed by the flow of steam.

3. The use of the link, which is not only a very convenient method of operating the valve, but at the same time it is an excellent apparatus for variable cut-off for all points of cut-off above 20 or 25 per cent.

The conditions by which a maximum economy of consumption is obtained are:

1. A pressure which stands in the neighborhood of 142 lbs. per square inch.

2. Cylinders of moderate dimensions, permitting the service running to be carried on with a sufficiently high point of cut-off, with 20 per cent. as the minimum.

3. Clearance spaces of suitable magnitude, ranging from 6 to 8 per cent. at each end of cylinder.

4. A free exhaust obtained by doing away with inside lap of the valves or even by the adoption of a certain amount of negative lap.

Stationary Engines.—The application of the compound principle to stationary engines is almost as old as the steam-engine itself.

Neglecting the early work of Hornblower and of Watt, we find in the early years of this century a two-cylinder engine built by Arthur Woolf, who built in a very complete way an engine showing the principles and advantages of the compound system.

The Woolf system, applied to orginal steam-engines which ran slowly but regularly, and which is adapted to a comparatively low pressure, has continued throughout the whole of this century to be received with marked favor in certain industrial centers without having really supplanted the single cylinder engine. It seems to have shown from its very first application, and in spite of the low boiler pressure used, a marked economy of consumption.

While the single-cylinder engine consumed 55 to 66 lbs., the consumption of a Woolf engine would scarcely be more than 40 to 48 lbs. As the average steam pressure raised, and under the impulse due to remodelling of the marine engine, the economical efficiency of the Woolf engine as it is more carefully studied and regulated has proven an important improvement.

In some tests made at Mulhouse, in 1876 and 1878, with these engines, the entrained water being estimated at 5 per cent., the steam pressure was 70 lbs. per square inch. Taking the total of the results obtained, we find them to average 22.88 lbs. of dry steam per H P. per hour for two vertical engines, and 22.26 lbs. for one horizontal engine.

In tabulating these results and drawing a curve we recognize the existence of a minimum of consumption which corresponds very nearly to a cut-off of one-twelfth if we consider the indicated work, and one-tenth if we use the effective work as the basis of comparison.

Marine Engines.—It is generally estimated that a saving of from 40 to 50 per cent. has been realized by the introduction of the compound system into the marine engines. But this should not be considered as entirely due to the application of double-expansion, for the increase of boiler pressure, rendered possible by the use of surface condensers, is a fact which ought of itself and outside of any special system of distribution effect an important improvement in efficiency. At the same time important improvements have been made in the mechanical arrangements of the apparatus: reduction of the volumes of the cylinders, better protection against cooling, the more general use of the direct system of connection and steeple construction, the increase in the number of revolutions per minute and the almost universal adoption of the link as a cut-off apparatus. All these modifications, which we may observe in passing have brought the marine engine to a point of close similarity to the locomotive, had their part in increasing the coefficient of efficiency. In reality, the economical results of to-day have only been obtained step by step, and not by the adoption of the compound system in itself.

Tests were made on the following vessels: *Duquesne*, 8,000 indicated H.P., the group of three Woolf engines; *Cigale*, compound two-cylinder engines, steeple; *Voltigeur*, three-cylinder compound, horizontal; *Mytho*, three-cylinder compound, steeple, in which it was estimated that the entrained water amounted to 5 per cent. of the total consumption. On the *Duquesne* the average consumption of dry saturated steam was 20.6 lbs. of dry saturated steam per H.P. per hour; on the *Cigale* it was 18.46 lbs.; on the *Voltigeur*, 18.89 lbs., and on the *Mytho*, 19.04 lbs.

If we consider the whole of the results furnished by these tests, we can say that the simple compound marine engine, working at a favorable point of cut-off and expansion, which is from four to 10 times the volume of steam admitted, will give a consumption of about 18.8 lbs. of dry steam per indicated H.P. The whole weight of feed-water will be 19.8 lbs. per effective H.P., but there is evidently no data in existence for calculating this last element to a certainty. If we accept the passive resistance at 10 per cent, the smallest proportion which has been given in the experiments in stationary engines, we obtain 20.9 lbs. of dry steam, or 22 lbs. of water per effective H.P., which seems to have been considered as a minimum.

The experiments given by Mr. Widmann permit us to determine in an approximate manner the net influence of the cut-off on the coefficient of economy. If we represent the whole of the results graphically by taking, for example, the actual fraction of admission, including the clearance space of the smaller cylinders for the abscissa and consumption for the ordinates, the grouping of the points obtained denotes the presence of a minimum of consumption at about 15 per cent admission. It may be further stated that the coefficient of consumption varies slightly when the actual admission point rises to, say, 30 per cent., or lowers to 10 per cent.; likewise in a Woolf stationary engine there exists a somewhat extended region of good efficiency.

Locomotives.—The economical results obtained in the transformation of marine engines ought to attract the attention of railway engineers. The adoption of the compound system having had as its essential object from the very start the reduction of consumption of fuel, most of the companies which have made the test have devoted themselves to showing by comparative figures the importance of the results obtained. Unfortunately this comparison is not based on a great number of cases, but upon data that has been somewhat imperfectly compiled. Most frequently new engines have been compared with other engines already in service which might differ from the type submitted to the test, not only in the system of steam distribution employed, but in power, steam pressure and general condition of repair. In all cases the results thus obtained are simply comparative, and cannot effect figures which express in any absolute manner the economical value of the type of engine under consideration. The only method which would permit an absolute certainty to be obtained is one which consists in showing, as we have already said, the results furnished by each type of engine on a common standard that has been rigorously defined, and which is nothing less than the effective work obtained therefrom. The first application of this method was made on the Southwestern Railway of Russia.

Experiments on the Southwestern Railway of Russia.—The first series of tests were carried on in the laboratory where the locomotives were arranged so as to act as stationary engines. The comparison of two engines was made: one a compound, the other a simple, exactly alike in other respects. The consumption of the compound engine was found to average about 26 4 lbs. of water per indicated H.P., while the ordinary engine consumed from 28.6 to 30.8 lbs. The consumption of both was high. This high consumption should be attributed to the fact that the two machines worked under very different conditions from that in actual service, which were clearly unfavorable from the standpoint of efficiency, as they involved a reduced pressure, slow turning and high expansion.

The second series of tests, intended to embody the same conditions as in actual work, was made in 1883 by Mr. Loewry on trains in service. The comparison was again made with an engine of the ordinary type and a Mallet machine, the first

having a steam pressure of 142 lbs. per square inch, and the second 160 lbs. The cylinders of the latter had a diameter of 16¼ in., and the other, 23.6 in. The consumption of water by the compound engine averaged 22.88 lbs. per indicated H.P. per hour; the simple engine consumed about 26.4 lbs. The 22.88 lbs. per indicated H.P. corresponded to 25.3 lbs. per effective H.P.

Still later the Southwestern Railway of Russia has made public the results obtained with four-cylinder passenger engines working under a pressure of 200 lbs. per square inch. The tests showed a consumption of 19.8 lbs. per indicated H.P., a figure which we can consider to be equal to 22 lbs. per effective H.P. It is an extremely favorable result, and one which if confirmed should cause this engine to be considered as having attained a degree of economical working which is very remarkable.

Experiments with a Compound Engine on the Northern Railway of France.—The Northern Railway of France has recently put into its express service a class of compound engines with four cylinders* working under a pressure of 200 lbs. per square inch. They are of great power, and the evenness of their running and the low consumption of water has been particularly remarkable. Great pains have been taken to establish by actual measurement the coefficient of economy of these engines, which seem to embody the most perfect type of compound locomotive that has yet been put into service.

Tests were made of these engines by the chronometer method and by the simultaneous use of the chronometer and dynamometer. They agreed in giving 22 lbs. in round numbers as the consumption of feed-water per H.P. per hour. The amount of water entrained was not measured, but it was estimated at 5 per cent. If this were the case, the consumption of dry steam amounted to about 20.9 lbs.

We had already found in the Woolf stationary engines that they consumed 22¼ lbs. of dry steam, or 23.8 lbs. of water, and the simple compound marine engines (the passive resistance having been estimated at a minimum of 10 per cent.), 20 9 lbs. of dry steam, or 22 lbs. of water.

We see that the Northern type of compound locomotive showed results at least as economical as those given by the stationary Woolf engines or the compound marine engines working condensing.

The absence of the condenser was compensated for by the use of a higher pressure, a greater rotative speed and probably lower passive resistances. The figures of the Northern engine, compared with the results obtained from the ordinary locomotives, are more remarkable in that the experiments were made at high speed, ranging from 46.6 to 51.5 miles per hour, where it was possible the point of maximum efficiency was passed.

It should be understood that the economical results given by these tests should be attributed to the particular type of engine experimented with, and not in any way to the general type of compound locomotives. The compound arrangement is capable of introducing a great variety of variables that may have a greater influence on its economy than those existing in ordinary engines. If in the case before us they have by careful study succeeded in regulating these different elements in the best possible manner—that is, the pressure, the area of steam passages, clearance space and intermediate receiver, point of cut-off in the two cylinders, etc.—it is clear that these same elements could be combined in another engine so that they would show less favorable results; the benefit of the compound arrangement would then be lessened, and might perhaps entirely disappear.

It has been impossible to investigate the variations to which the efficiency would be subjected at different points of cut-off and at different speeds. The test, however, seemed to have established the fact that for moderate speeds of from 45 to 50 miles per hour the efficiency does not vary very much from its maximum when the effective expansion varies from 4 to 10.

Corliss Engines.—Numerous reports of experiments concerning the efficiency of the Corliss engines have been published, most of them emanating from their builders. The figures are necessarily somewhat confusing, and some claim a degree of economy that it would be difficult to accept without further investigation. We will limit ourselves to the reproduction of the experiments made at Creusot in 1883, a *résumé* of which was published by Mr. Delafond. These tests, by reason of the extreme care which was taken in all of the measurements, and the number and variety of the tests, can be considered as fixing under the seal of the best possible authority the practical coefficient of economy of the Corliss engine.

The engine tested was rated at about 200 H.P.; the work was measured in effective and indicated H.P. The ratio of the two kinds of measurements gave the value of the passive resistances. Furthermore, and this is of special interest from a standpoint of comparison of marine engines and locomotives, they worked successively with and without the condenser.

Test with the Condenser.—The results obtained while running with the condenser permit the Corliss engine to be compared with compound marine engines or with Woolf stationary engines. The tests were made with pressures ranging from 55 lbs. to about 115 lbs. per square inch. They show that the highest pressure gave the most favorable results. With the boiler pressure of 110 lbs. per square inch the following results were obtained for water consumption at different points of cut off:

Cut-Off.	Indicated H. P.	Effective H. P.
.055	16.81 lbs.	21.43 lbs.
.067	16.47 "	20.65 "
.125	17.37 "	21.01 "

The uniform speed was 60 revolutions per minute. The cylinder had a steam jacket. The results of these tests show that a very short cut-off (from 6 to 7 per cent.) has a favorable influence on the efficiency, but it is necessary to note that where the distribution is made by means of a catch the actual point of cut-off is always a little later than the apparent.

Tests without the Condenser.—Tests without the condenser can be made with and without the steam jacket. The use of the steam jacket was shown to have an advantage at least in case of moderately high speeds. The steam pressure was varied between wide limits even when running with the condenser, and the most favorable results were attained with the highest pressure. Under these conditions the following figures for water consumption have been obtained for different points of admission:

Cut-Off in Per Cent. of Stroke.	Indicated H.P.	Effective H.P.
11	22 49 lbs.	26.61 lbs.
13	21.82 "	25.35 "
16	22.05 "	25.04 "
20	21.20 "	23.68 "

The speed was 60 turns per minute.

We may state here that, contrary to the observations made when running with a condenser, short points of cut-off are unfavorable, and the efficiency increases when the point of admission rises to 20 per cent. The most favorable point of cut-off in all these series of tests was obtained at 20 per cent.—23.68 lbs. of water per effective H.P. per hour, or 22¼ lbs. of dry steam. The diminution in efficiency due to the removal of the condenser caused a drop of about 15 per cent.

Locomotives.—The application of the Corliss release has been recently attempted on locomotives. It does not, however, seem well adapted to the wide range through which locomotives are called upon to work with their quick variations, together with the necessity of running in opposite directions.

The State Railway put a number of high-speed engines at work in 1889. They were designed by M. Bonnefond, who by arrangement of simple mechanical appliances seemed to have surmounted the many difficulties which beset this problem.

These engines were tested on the run from Château-du-Loir to Courtalain, on a section where there was a steep grade of 1 per cent. for more than 6 miles. In order to determine the influence of speed on one of the trials, the whole run was divided into two parts—the first being almost perfectly level, the second being entirely on this grade. The average results were almost exactly 22 lbs. of water per H.P. per hour, the figures agreeing with those obtained by the Northern compound engines.

On the other hand, the efficiency rose with the speed, a result which ought not to surprise us; the excess of compression which, in single-valve engines, manifests itself at high speeds, being avoided, thanks to the independence of the exhaust, so that a benefit was derived from the thermic advantages inherent in high velocities.

Résumé and Conclusions.—The observations made and analyzed in this paper lead us to a number of conclusions which can be given in a few words:

First, the locomotive engine, considered either under its usual form with a single valve, or under the improved form, resulting from the application of the compound system, or with a Corliss valve, is susceptible of an economic efficiency

* See American Engineer, page 114, March, 1893.

as favorable as the best stationary or marine engines having the same system of steam distribution, in spite of the advantages which these latter derive from the use of the condenser. When making a comparison with these same engines working without a condenser, the locomotive has a marked advantage.

Second, the consumption of water in a locomotive with single valve under favorable conditions as to the cut off and pressure can be lowered to less than 24.25 lbs., including entraining, or to 23.15 lbs. of dry steam per effective H.P. per hour.

The consumption of 23.15 lbs. of water or 22 lbs. of dry steam can be considered as the limit corresponding to the most perfect condition of regulation. The use of the compound system (four-cylinder type of the North of France) permits the consumption of water to be lowered to 22 lbs. or to 20.9 lbs. of dry steam per effective H.P. per hour. The use of the Corliss type of steam distribution, such as the Bonnefond type on the State Railway of France, has given exactly equivalent results—22 lbs. of water, or 20.9 lbs. of dry steam per effective H.P.

Third, in the case of a locomotive with the ordinary valve the most favorable conditions of economical consumption are as follows: A pressure of about 145 lbs. per square inch; moderate-sized cylinders permitting a cut-off at 20 per cent. of the stroke to be regularly used; steam passages opening freely into the admission ports, and especially into the exhaust; an ample clearance space of from 6 to 8 per cent. at each end of the stroke; a moderately high speed of rotation without being excessive, ranging from 150 to 200 turns per minute.

Under the usual conditions of construction and regulations of our locomotives, the consumption varies from 24.25 to 26.5 lbs. when the running conditions require a somewhat high power to be developed at a moderate speed. The consumption rises to 28.75 lbs., and under exceptional conditions to a still higher figure, in consequence of special conditions of running and profile, so that it may become necessary to use a cut-off that is too long or one that is too short, or even wire-draw the steam at the throttle-valve. The use of a cut-off that is too short, or an exaggeration of the wire-drawing of the steam, can always be avoided by intermittently opening and closing the throttle valve. Under these conditions the consumption of an engine in good condition will always be maintained at less than 26.5 lbs., except in rare cases of very heavy grades or high speed.

Fourth, the application of the compound system seems to require, as a condition of really advantageous employment, a higher pressure of steam ranging from 170 lbs. to 200 lbs. per square inch; it requires that the steam passages should be large and that the clearance spaces should have a high capacity. Under these conditions it is possible to carry the ratio of expansion higher than with the ordinary engine. The use of very high expansion does not give increase of economy, but involves a loss of efficiency less than in the case of single-cylinder engines.

In this sense, then, it may be said that the compound engine gives the locomotive a greater suppleness for adapting itself to variations of load and profile. Too high a speed causes a loss of efficiency to appear through the increase of compression, just as it does in the case of the ordinary engine.

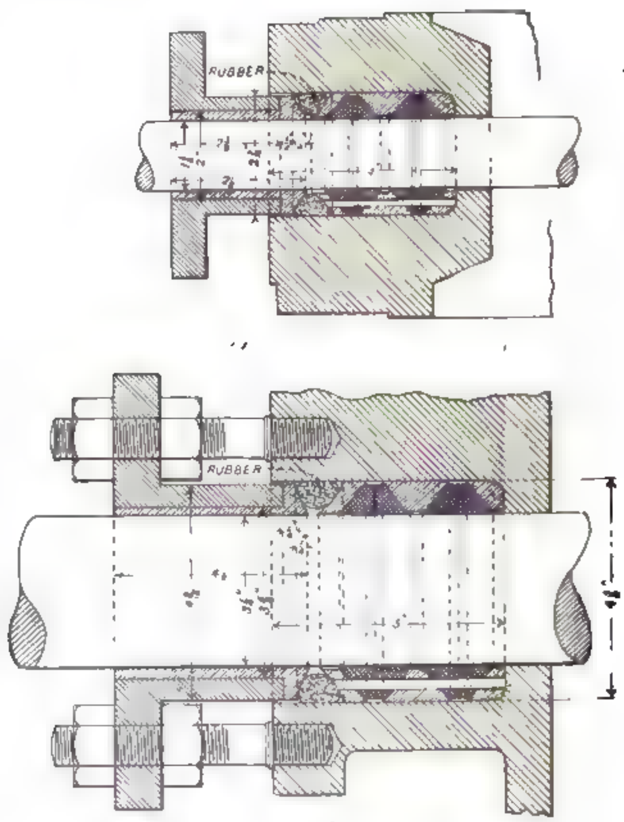
Fifth, steam distribution with multiple valves permit the pressures of from 170 lbs. to 200 lbs. per square inch to be advantageously used, but without the use of a very high pressure being essential to their action. Just as in the compound system they permit a marked increase in the ratio of expansion to be used without resulting in any sensible loss of efficiency. Owing to the independence of the exhaust they are not subjected, like engines with the ordinary methods of distribution, to excessive compression at high speed. They seem destined to effect a maximum of economy in water consumption on high-speed trains.

SOME SPECIAL APPLIANCES IN USE ON THE FLINT & PÈRE MARQUETTE RAILROAD.

TORPEDO-CASE.

When the equipment of the rear brakeman consisted of two lanterns and a flag, there was little or no difficulty in his handling them without hindering his own free motions; but since the fusee and the torpedo have been added to his outfit, his hands are too full for quick and convenient work in changing trains and in properly protecting the rear end of his train. It has, therefore, become necessary that some sort of case should be devised in order that as many of these pieces shall be contained in one bundle as possible.

We illustrate herewith a very convenient form of case devised by Mr. T. J. Hatswell, Master Mechanic of the Flint & Père Marquette Railroad. The dimensions of the case are all given on the drawings, the external diameter being 8½ in., with a total length of 26½ in. At one side there is a partition for a flag, the larger portion of the space being occupied by a chamber to hold the fusees. At the other end there is a torpedo-case whose cap is held in position by a bayonet motion; a hook on the handle provides for a lantern attachment, so that if the man has his lantern and his case, everything can be carried in one hand. This, of course, does not include extra lanterns or signal lights, but they can be bunched and gathered in one hand; while on going back, the man simply is to pick up one thing and he is thoroughly equipped with fusees, flag and lantern.



METALLIC PACKING, FLINT & PÈRE MARQUETTE RAILROAD.

METALLIC PACKING.

The metallic packing illustrated herewith is very simple in construction and efficient in service. The single cross-hatched lines denote cast iron, the dotted hatching is brass and the double hatching is soft metal. It will be seen that the rings are beveled. The backing of the soft metal rings which comes down against the rod is vertical to the center line of the latter, while the brass rings are beveled, but are not in two pieces. The action is exceedingly simple, as a gland screwed in the beveled face of the brass forces the soft metal down against the rod, while it in turn is sprung out against the larger diameter of the stuffing box. A piece of rubber serves to cushion the pressure exerted by the gland against the brass, and to avoid the danger of metal to metal contact causing a rigid cramping of the rings. The rings are split in order to allow for radial expansion and contraction, and the cast-iron gland is bushed, as it may be seen, with brass.

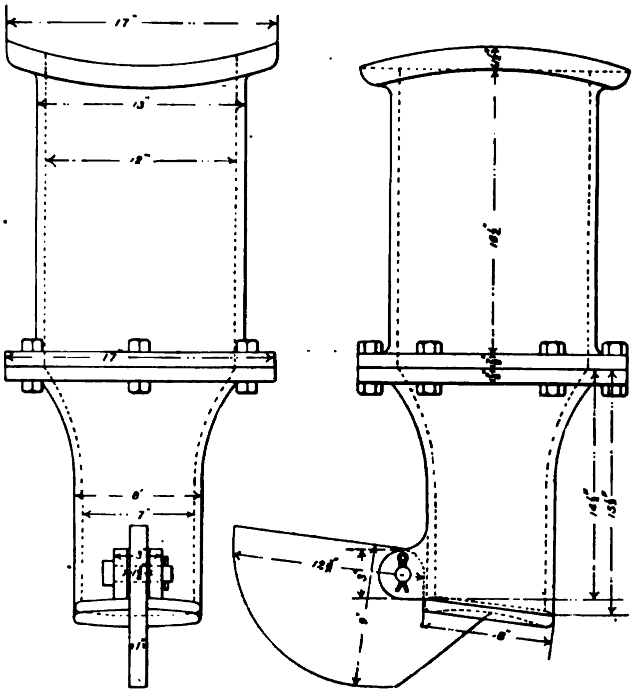
CINDER TRAP.

Mr. Hatswell has in use an exceedingly simple cinder trap for the front end of his locomotives. There are no slides, no wearing parts and nothing to get out of order or to leak; the construction is so simple that comment or description is almost unnecessary. The bottom of the drop is pivoted at the point shown just above the lower end of the shute, and consists of a slightly convex plate fitting into the bottom of the shute and held there by the counterweight extending out at the left of the pivot. The dimension of the drop is given on the engraving so clearly that any mechanic can reproduce it.

MR. MAXIM'S FLYING MACHINE.

The London *Times* of August 8 contained the following account of the recent trial of Mr. Maxim's flying machine:

"For some years past Mr. Maxim, as is well known to our readers, has been carrying out experiments with a view to constructing a machine able to propel itself through the air. His efforts have now been crowned with success. On Tuesday last, he, together with two of his men, traveled through the

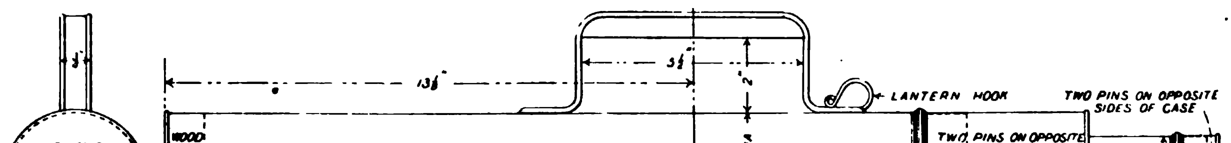


CINDER TRAP, FLINT & PÈRE MARQUETTE RAILROAD.

air on his flying machine for a distance of some 500 ft. This, of course, does not mean that the problem of aerial locomotion has been completely solved; on the contrary, very much has to be done before flying will be practicable for the human race. What Mr. Maxim has done is to show that it is possible to make a machine combining so much power with extreme lightness of construction as to be able to travel through the air, carrying its water, its fuel and its engineers with it.

For his experiments, which have been conducted near Bexley, in Kent, Mr. Maxim has laid down a track of light railway some 1,600 ft. long, on which the machine runs. On each side of this railway, and standing about 2 ft. above it, is an inverted track of strong timber. From each side of the machine there project two arms carrying flanged wheels, which press against the lower side of the timber track whenever the machine rises more than an inch or two from the rails, and so prevent it from soaring into the air. On Tuesday, as is plainly shown by the marks on the timber, the machine, almost directly after starting, rose from the metal rails and sailed along for some hundreds of feet, held down by the outside check-rail. It would doubtless have gone the whole length of the railway but for an unfortunate accident. Mr. Maxim, calculating that the main stress would fall on the forward pair of projecting arms, had made the pair behind somewhat too weak, so that they bent under the strain they had to bear. In this way the back part of the machine was liberated from the control of the check-rail, and naturally began to sway violently. The front wheel on the left hand side in consequence jumped the rail, and the only remaining guide wheel plowed into the timber, broke off one of the posts, smashed its flange, twisted its axle and liberated the machine from the track altogether. It was then soaring at a considerable angle when it was brought to a standstill, considerably damaged, on the turf by Mr. Maxim's shutting off steam. Here, then, is certain evidence that it had really flown and had not merely run along the rails. The turf is not at all plowed up, as it would inevitably have been had the machine slipped off the rails and run along the ground. On the contrary, the wheels have sunk cleanly into the earth, just as they would have done had the machine been dropped down perpendicularly, as in fact it was. These and several other facts are amply sufficient to prove that it really did rise from the rails, even without the testimony of the witnesses who were specially placed to observe what occurred.

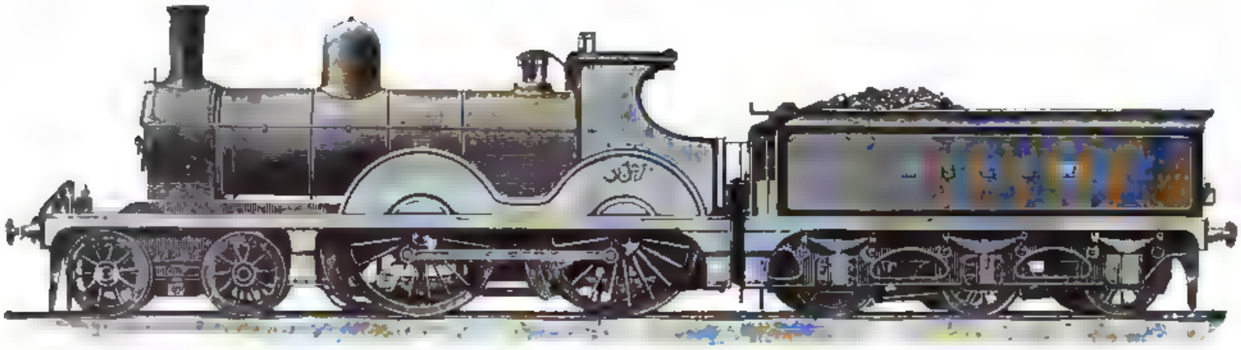
"The machine from which this striking result has been obtained is a marvel of engineering ingenuity. With its four side sails and 'aeroplanes' set, it is over 100 ft. wide, and is described as looking like a huge white bird with four wings instead of two. It is propelled by two large two-bladed screws, resembling the screw propellers of a ship, driven by two compound engines, which are, in proportion to their weight, the most powerful that have ever been made. They can develop 1 H.P. for every 2 lbs. of their weight. The boiler is of novel design, and consists of very many tiny tubes, through which there is a forced circulation of water. It is so efficient that the pressure can be raised from 200 lbs. per square inch to 300 lbs. in about a minute, and is more than capable of supplying steam to the engines even when they are making 500 revolutions a minute. In Tuesday's successful trial Mr. Maxim started with a pressure of 310 lbs, which had risen to 320 lbs. when he had traversed some 500 yds. To realize the full meaning of this result, it must be remembered that these 500 yds. were run at the rate of 45 miles an hour, the propellers making some 500 revolutions per minute. The fuel used was gasoline. The total weight of the machine on Tuesday was about 8,000 lbs., while the engines were given a lifting power of about 10,000 lbs. There was thus a surplus flotatory power of some 2,000 lbs., or, in other words, the machine could have flown with something near that amount of extra weight above what it actually carried. It was, of course, this 2,000 lbs. of surplus lifting power that did all the mischief, by throwing on the controlling axles a strain they had not been designed to bear. After such an experiment few engineers will in future be found willing to deny, as some have in the past, the possibility of constructing an aerial vessel so powerful and yet so light as to be able to propel itself and its crew through the air, together with water and fuel sufficient for a voyage."



TORPEDO CASE, FLINT & PÈRE MARQUETTE RAILROAD.

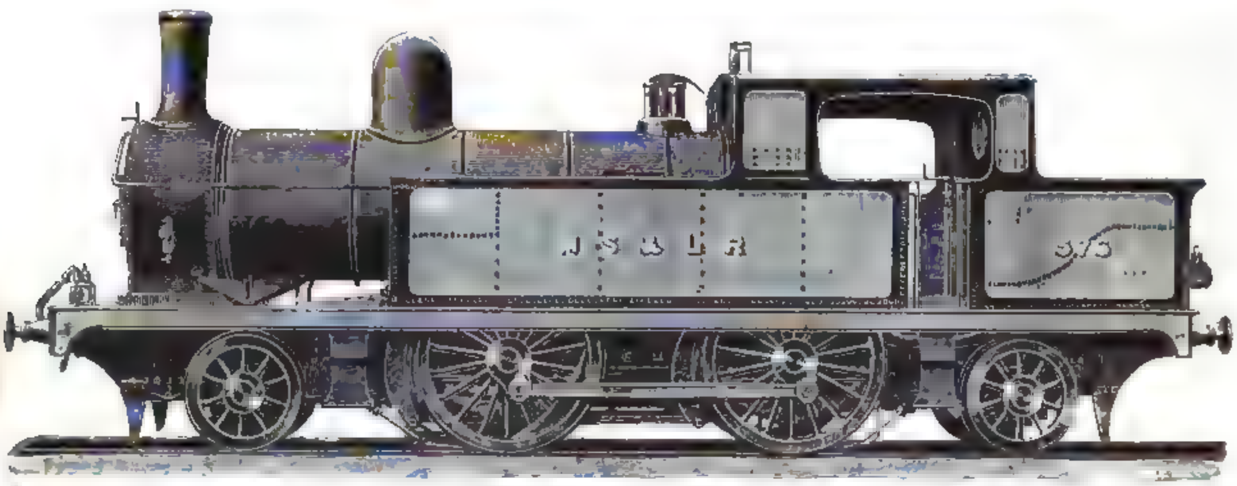
STANDARD LOCOMOTIVES ON THE MANCHESTER, SHEFFIELD & LINCOLNSHIRE RAILWAY.

We republish herewith from *Engineering* a set of engravings showing the types of standard locomotives in use on the Manchester, Sheffield & Lincolnshire Railway, in England. They were designed by Mr. Harry Pollitt, the locomotive superintendent for the line. The main particulars regarding these locomotives will be found in the following list of dimensions:

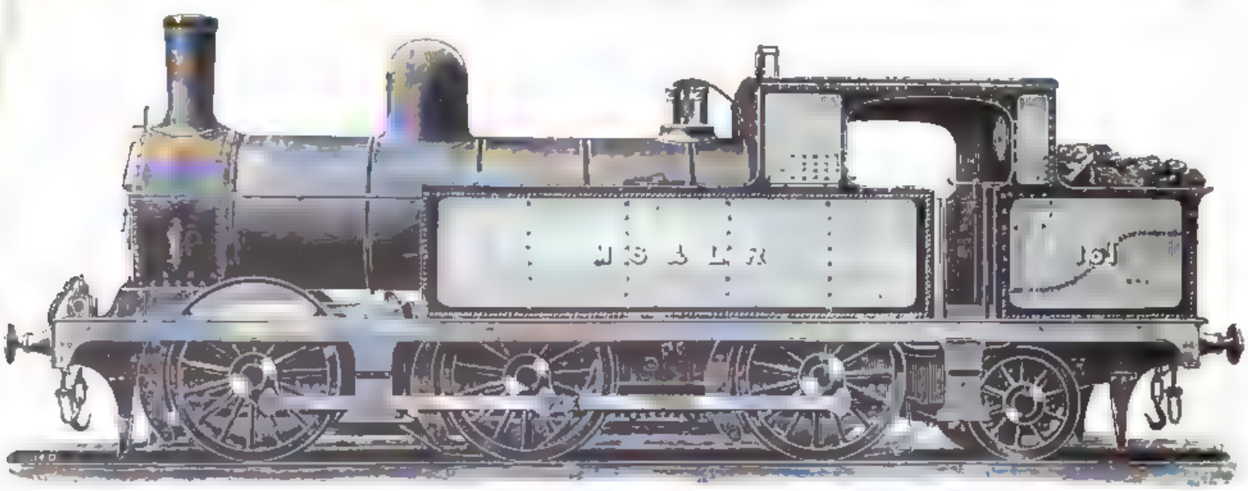


EXPRESS LOCOMOTIVE.

GOODS LOCOMOTIVE



LOCOMOTIVE FOR LOCAL TRAFFIC



GOODS TANK LOCOMOTIVE.

TYPES OF STANDARD LOCOMOTIVES, MANCHESTER, SHEFFIELD & LINCOLNSHIRE RAILWAY.

Express Locomotive:

	Ft.	In.
Diameter of cylinders	1	6
Stroke " "	2	6
Diameter of bogie wheels	3	6
" " coupled wheels	6	9
Distance between centers of bogie wheels	5	9
" from center of bogie trailing wheels to center of driving wheels	7	5
Distance between centers of coupled wheels	8	7
Total wheel base	21	9
Boiler pressure	160 lbs. per sq. in.	

	Tons.	Cwt.
Weight loaded: On bogie	13	19
" " " driving wheels	16	10
" " " trailing "	15	11
Total	46	0

Tender:

	Ft.	In.
Diameter of wheels	3	9
Wheel base	13	0
Capacity of tank	3,000 galls.	
Total weight loaded	35 tons.	

Goods' Locomotive:

	Ft.	In.
Diameter of cylinders	1	6
Stroke	2	2
Diameter of coupled wheels	5	1
Distance between centers of leading and driving-wheels	7	11
" " " " driving and trailing-wheels	8	7
Total wheel base	16	6
Boiler pressure	160 lbs. per sq. in.	

	Tons.	Cwt.
Weight loaded: On leading wheels	14	14
" " " driving "	15	8
" " " trailing "	13	8
Total	43	10

Tender:

Same as for express engine.

Locomotive for Local Traffic:

	Ft.	In.
Diameter of cylinders	1	6
Stroke	2	0
Diameter of radial wheels	3	6
" " coupled wheels	5	7
Distance between centers of front radial wheels and driving wheels	7	10½
Distance between centers of coupled wheels	8	7
" " " " hind coupled wheels and hind radial wheels	7	0
Total wheel base	23	5½
Boiler pressure	160 lbs. per sq. in.	
Capacity of tanks	1,400 galls.	

	Tons.	Cwt.
Weight loaded: On leading wheels	12	6
" " " driving "	17	18
" " " hind coupled wheels	16	8
" " " " radial wheels	12	8
Total	59	0

Goods' Tank Locomotive:

	Ft.	In.
Diameter of cylinders	1	6
Stroke	2	2
Diameter of coupled wheels	5	1
" trailing (radial) wheels	3	6
Distance between centers of leading and driving wheels	7	11
" " " " driving and hind coupled wheels	8	7
" " " " hind coupled wheels and trailing wheels	6	0
Total wheel base	22	6
Boiler pressure	160 lbs. per sq. in.	
Capacity of tanks	1,400 galls.	

	Tons.	Cwt.
Weight loaded: On leading wheels	15	4
" " " driving wheels	16	3¼
" " " hind coupled wheels	14	18
" " " trailing wheels	13	13
Total	59	18¼

A SUCCESSFUL ARBITRATION.

The only case in three years where an umpire's services had to be called in to settle a disputed question of wages under the form of arbitration adopted by the National Association of Builders, is that the report on which will be found below, and of special interest in view of the present condition of the labor question:

DECISION OF UMPIRE OF JOINT COMMITTEE, MASON BUILDERS' ASSOCIATION AND BRICKLAYERS' UNION.

I have carefully considered the arguments on each side of the contention between the Mason Builders' Association and the Bricklayers' Union No. 3 of Boston and vicinity, as given at the hearing Wednesday, June 27, and herewith state briefly the points at issue and the conclusion forced upon me.

The members of the committee of the Mason Builders' Association aver that, in consequence of the present depressed condition of business, building has decreased, values have declined, and that, at the former rate of wages and material, there is no inducement for owners of real estate to venture on new enterprises. They, therefore, ask that the reasonable reduction in wages of bricklayers of four cents per hour, or about 10 per cent., be yielded, from date to January 1, 1895. The present agreement is on the basis of 42 cents per hour and eight hours a day, overtime to be paid for at an added rate of 50 per cent., or "time and a half," as it was expressed.

Collateral arguments and instances were adduced, but the above is the chief ground upon which abatement is asked. Selfish interest was disclaimed, and the lessened wage, the builders believed, by stimulating business, would result in more and steadier work for the bricklayers.

To which the members of the committee representing the Bricklayers' Union rejoined:

First, that the gravity of the alleged depression was exaggerated, and they endeavored to show from figures obtained at the office of the Inspector of Buildings that the first four months of 1894 show an increase in the number of completed buildings above the same period of 1893, implying that the hard times had failed to materially injure the building business.

Second, a weighty reason why wages in Boston should not be cut was their present low rate as compared with other cities of the country, New York, Baltimore, Indianapolis and Denver paying 50 cents per hour; Philadelphia, 45 cents; St. Louis, 55 cents; and Cincinnati, 56 cents; all on a day of eight hours. Buffalo pays 36 cents and St. Paul, 45 cents, both on a day of nine hours.

Third, the irregularity of work and the large amount of time lost through enforced idleness—not only from cessation of outside bricklaying in wintry weather, but from unavoidable delay of material and waiting for other mechanics at all times—really reduces the seemingly high rate of wages to a low average. It was affirmed, and not denied, that the average workman does not earn over $11 to $12 per week, or about $600 per year.

Other contentions there were, but the three given cover the points deserving attention.

The amicable spirit of both parties and the evident desire to arrive at a just conclusion were manifest. In the same spirit let me consider the points raised.

I agree with the Mason Builders' Committee that the present depression is serious; that buildings have been put up on speculation in excess of the demand; that new enterprises are checked, contracts are few, and that the large number of empty houses for sale and the numerous idle bricklayers are sufficient to show the situation. I am not convinced, however, that a small abatement of mechanics' wages will stimulate new business.

The first contention of the Bricklayers' Union Committee is baseless and misleading. The increased number of buildings completed in the first four months of 1894 does not disprove the great depression, for it is evident that the initiation of these completed buildings antedates the panic. If the dates of beginning and the length of time occupied in the building were given, the statistics would be found valueless in this discussion.

The second objection urged against the cut of wages proposed is the comparative low price paid in Boston when the other great cities are considered. On its face it is a strong point, but conditions are always found on examination to account for the discrepancy. If there were no counter-balancing advantages in living in Boston over living in Cincinnati, it is safe to say that with bricklayers' wages at 56 cents per hour in the latter place as against 42 cents here, there would be a hegira of workmen from this city to that. But the fact remains that, instead, bricklayers are drawn to Boston, and, as appeared in the testimony, from cities where the nominal wage is higher.

An agreement of 50 cents per hour in Denver means nothing when building is paralyzed, as at present, and employment in that line practically suspended.

The third reason for leaving undisturbed the current pay has decided force, correcting the unwarranted conclusion that large wages per hour are necessarily large in the gross, as was

THREE-TON TRAVELING CRANE AT THE SHIPYARDS OF THE F. W. WHEELER CO., WEST BAY CITY, MICH. BUILT BY THE BROWN HOISTING & CONVEYING CO., CLEVELAND, O.

satisfactorily explained, by unsuitable weather and inevitable delays from causes beyond the bricklayers' control.

I deem it unnecessary to elaborate further the arguments or pleas advanced on both sides, and proceed to give the conclusion I have reached.

If the hard times and the dullness in building were caused by excessive wages paid to bricklayers and other similar mechanics, there would be ample reason for granting the mason builders' request. But it is evident that such is not the case, and that some undefined cause makes the lot of both parties a trying one. Attempting to curtail the earnings of either cannot, therefore, be effective. Moreover, the mason builders have this advantage, they enjoy opportunities for profits on contracts that may furnish a fund with which to tide over such times as the present. The bricklayers have no chance for exceptional profits, and while their wages may be adequate to support themselves and families in prosperous times, they are in trouble when work fails them.

Again, for the mechanic to raise his wages is a hard and slow process, and if lowered to meet an emergency, involves great exertion to recover them as times improve. They are, consequently, the last item of expense to be deliberately reduced.

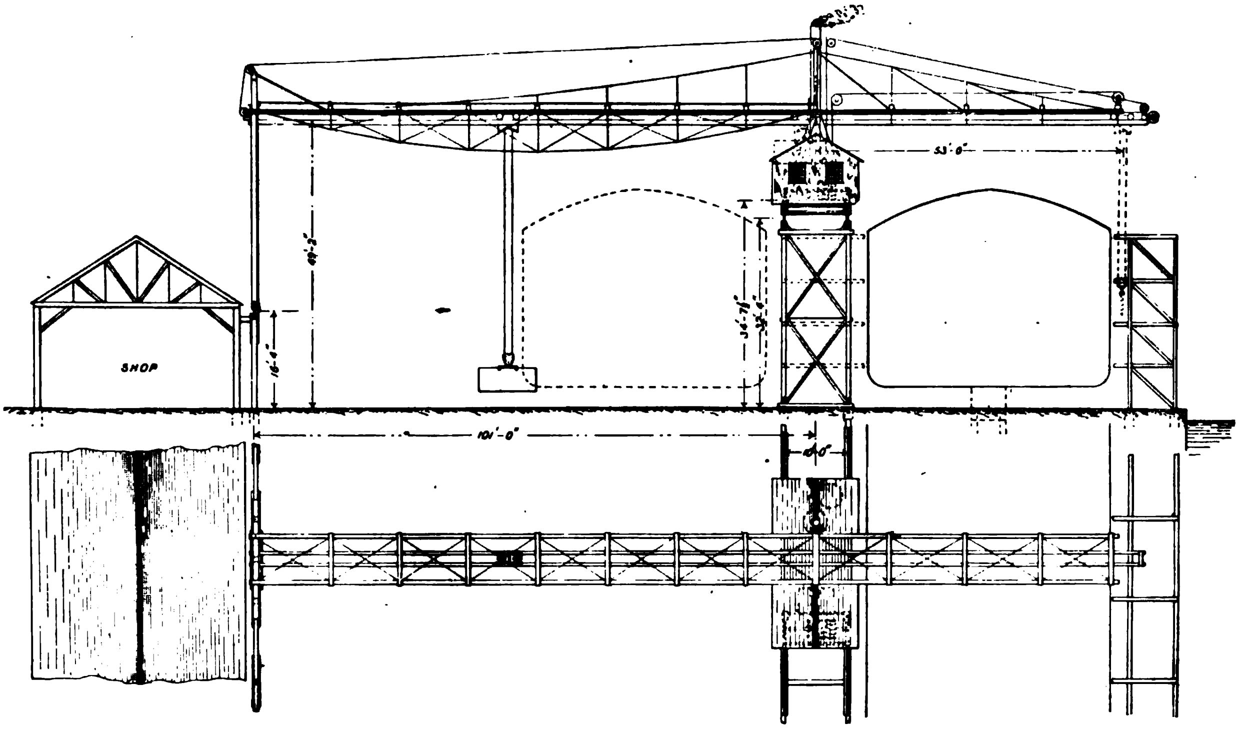
instituted this fair and reasonable method of adjusting your differences of opinion. Respectfully,

(Signed) William Lloyd Garrison,

Boston, July 6, 1894. *Referee.*

THE BROWN TRAVELING CRANE.

The illustration on page 408 represents the shipyards of F. W. Wheeler & Co., at West Bay City, Mich. The building at the left is the forging and bending shop, where the form irons for the iron vessels are bent and the plates rolled to shape. On the right there is shown the scantlings of a vessel in course of construction, while the traveling crane used for carrying material from different points about the yard to vessels on the stocks is shown in the act of conveying a sheet from the shop to the boat. This crane was built by the Brown Hoisting & Conveying Company, of Cleveland, O., and has a span of 101 ft. from center to center of supporting piers, with a cantilever extension over the vessel on the building berth that allows the carriage to travel 53 ft. beyond the center of the pier. One end of the bridge rests on a single pier on a single-rail track, while the cantilever end is on a double track that is



THREE-TON TRAVELING CRANE, BUILT BY THE BROWN HOISTING & CONVEYING COMPANY, CLEVELAND, O.

It may pertinently be asked, if wages were fixed at 36 cents instead of 42, who would benefit by the concession? Chiefly the mason builders, who have unfinished contracts estimated at the higher figure. It would be a transfer without consideration from the laborer to the employer. New contracts would be figured on the cut rate, and unless increased building resulted from diminished wages, nothing would be gained.

My own belief is that the primal cause of the cessation of building centers in the excessive and speculative advance in land values (aggravated by the financial distrust of our national credit), and that the return of better times must be preceded by the decline of the prices demanded for land. When they fall, capital will again be encouraged to invest in new buildings. Land values are the last thing to decline in a panic, but until they do, enterprise is checked and labor waits. The real enemy against whom both builders and employés should unite is land speculation, for he who controls the opportunity controls also the profits of him who uses it.

Convinced, therefore, that no general gain will accrue to the mason builders by the cut of the bricklayers' wage, and that the amount is too small to signify for the stimulation of business, I, therefore, decide that no abatement from the current rate be made.

Permit me to express my gratification, in view of the deplorable labor conflict now raging in the West, that you have

10 ft. from center to center of rails. The engine and boiler house is located over the double-track pier. The house is built of corrugated iron, and contains a specially designed double engine fitted with patented band friction clutches. The cylinders are 8½ in. in diameter, with a piston stroke of 12 in. This engine drives one hoisting drum 36 in. in diameter with a 9-in. face, and two racking and traveling drums each with a diameter of 36 in. and a face of 7 in. Steam is supplied by an upright boiler 48 in. in diameter.

The entire structure is of iron with the exception of the tramway, track stringers, cross beams and frame of the engine house.

The capacity of the crane is rated at 6,000 lbs., and the drums are so geared to the engine that a hoisting speed of 150 ft. per minute is obtained. The speed of the trolley is 500 ft. per minute, and that of the whole structure 200 ft. per minute.

When we compare the ease and facility with which all parts entering into the structure of a vessel can be put in position by such a machine, we can readily see the force of the claim on the part of the owners that the crane paid for itself in six months—that is, the difference in cost of handling material by machine, compared with the cost of handling by the methods previously employed, amounted to the cost of the machine in six months.

The line engraving of the crane shows it with two vessels beneath it, and this can be readily done where end launching is used; but where side launching prevails, as in the yards of F. W. Wheeler & Co., no vessel can be located where the one shown by the dotted lines is placed. In this particular instance the central vessel is not built, and the crane travels down a long line of building berths from which the vessel is launched sideways into the water that is indicated at the right of the engraving. We do not wish to be understood, however, as stating that the end or stern launch is not used in these yards as it is, but the side launch has also been employed for many of the largest vessels built by the firm.

THE INFLUENCE OF CIRCULATION ON EVAPORATIVE EFFICIENCY OF WATER-TUBE BOILERS.

In our issue for June we published a paper on water-tube boilers, and the discussion thereon by the members of the American Society of Mechanical Engineers. Those of our readers who have followed the matter will be interested in a paper recently read before the Institution of Naval Architects by Mr. John I. Thorneycroft. For the engravings used in illustration of the paper we are indebted to the *Engineer*. Mr. Thorneycroft said:

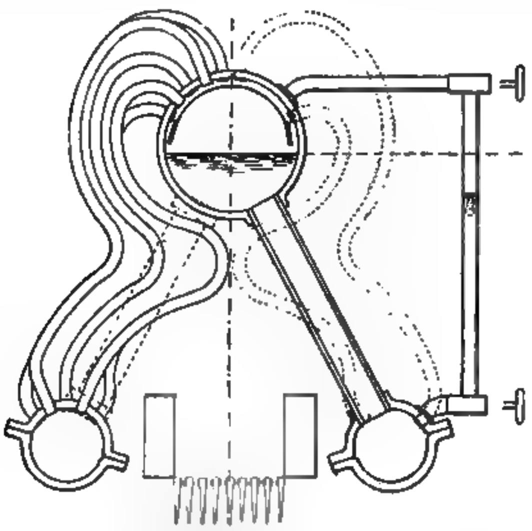


Fig. 1.

"To obtain the highest evaporative duty from a given tube service, it is necessary that the contents of the tube should consist of, as far as possible, water only; and to attain this result the steam must have the freest possible egress from the tubes, and must also be carried from them by an energetic circulation of water in a constant direction. To some of the leading features which affect these conditions I would now call your attention. Considering the boilers shown in figs. 1 and 2, if the pressure in the lower vessel—that is, at the bottom ends of the generating tubes—is due to the full depth of water in the boiler, in addition to the steam pressure, then any reduction of density in the generating tubes will all be available for causing circulation, and thus any reduction in pressure in the lower vessel, below that due to the head of water in the boiler, is a direct loss to the energy of circulation, so that variations of this pressure are of great importance. These variations can be conveniently measured by a pressure column formed of a long gauge glass connecting the steam of the upper vessel with the lower vessel. The difference of the water-level in this glass from the water-level in the upper vessel is a direct measure of any reduction of pressure in the lower vessel.

"I have made experiments, taking observations from such pressure columns fitted to the boilers shown in figs. 1 and 2, when they were working under different conditions, the rate of evaporation and steam pressure being varied for the several arrangements of boiler, which were: 1. Generating tubes delivering above water. 2. Generating tubes delivering below water. 3. Generating tubes delivering below water—without any special undertake tubes.

"The curves given in diagram 3 show graphically the results of these experiments; the falls of pressure in the lower vessel are plotted as ordinates, and rates of working as abscissæ. It will be seen that the rate of working has been taken up very high, probably more than double ordinary working, the object of doing this being to ascertain up to what rate each arrangement can be worked with safety. In the first series of curves the results recorded are obtained from the boiler, fig. 1, with the generating tubes delivering above water. It will be seen from the curve that, as the rate of working is increased, the pressure column falls slightly, and at an evaporation of 20 lbs. of water per square foot of heating surface stands at 85 per cent. of the maximum; and by halving the working pressure the results are not sensibly changed.

"The next series of curves is taken from the boiler, fig. 2, which has the same heating surface, etc., as fig. 1, but the top ends of the tubes deliver below water. It will be seen that the curves fall more rapidly than the first series, and that by halving the working pressure the pressure is distinctly reduced in the lower vessel.

"The third series was obtained from the boiler, fig. 2, by plugging up the down tubes, so that some of the generating tubes had to act as down tubes for the supply of the others, the feed-water of all being delivered into the upper vessel. In this case the character of the curve changes from the first two

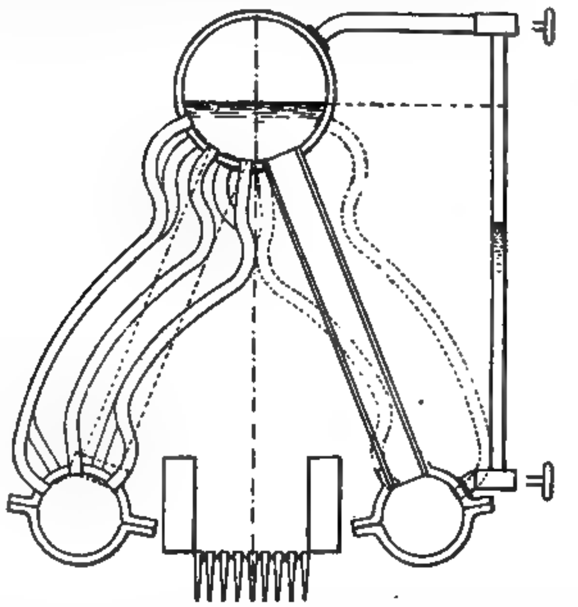


Fig. 2.

series very much. A diminution in pressure of working causes the pressure column to fall very much; in the case of the pressure being only 28.75 lbs. per square inch absolute, it fell to about 46 per cent. of the maximum. The most important point, however, apart from this low pressure, but a result of it, is that from any given pressure a critical rate of working is arrived at when the pressure begins to rise again with increased rate of working, thus showing an increased pressure in the lower vessel, caused by the steam being unable to get out at the top ends of the tubes fast enough, so comes out at the bottom ends as well. It will be seen from the curves that the lower the pressure of working the sooner this critical point is arrived at, and I found that when the evaporation was pushed beyond the critical point the tubes were not safe from overheating; but by taking the tubes intended for downtakes, and extending their upper ends above the water surface, so that water could not go down, and the steam in the lower vessel could readily get away to the separator, it was possible to increase the rate of evaporation somewhat, inasmuch as the facility for the tubes getting rid of their steam was increased.

"Contrasting the different conditions of working of the water tubes in the three series of experiments I have described, and noting what slight differences these conditions may necessitate in the design of a boiler, the nearness to success which a boiler intended for hard forcing may be, and yet fail, is clearly shown.

"In conclusion, I would submit that the absence of special down tubes limits to a great extent the amount to which a boiler can be safely forced, and shows to obtain the highest rate of working with safety and efficiency these special down

tubes must not be neglected; and still further, the tubes should deliver above water, as then the circulation, as I have previously shown, is double that when the tubes deliver below water. So that this rapid circulation is a most important condition for hard working."

CENTRIFUGAL PUMPS.*

By John Richards.

INTRODUCTORY.

The essay to follow will be a peculiar one in some respects, a technical subject dealt with empirically, and in many cases by controversion of assumed data respecting centrifugal pumps, perhaps mistakably now and then, but in all cases from observation and actual experience in designing, constructing and operating such pumps.

These pumps are a class of machines *sui generis*, that defy the mathematician, and, as an old workman once remarked to the writer, "have more tricks than a circus mule." One of these tricks is to give no external hint of the complex forces and condition set up in operating. For this reason, and for various other reasons, they have no literature to this time that has much aided those who make centrifugal pumps.

There is, perhaps, not in the whole range of organized machines any other that will not admit in greater degree of rules that have general application. Formulæ, such as exist, are ignored by the practical pump maker, who soon learns, to his cost sometimes, that computations will not supply proportions or define the working conditions required, and that he must proceed tentatively and tediously to ascertain the best forms of construction for particular uses, and for the head or pressure in each case. This statement will require some explanation.

Lying before us while writing this is data for constructing centrifugal pumps by M. D. Thompson, taken from Vol. XXXII, Transactions of the Institute of Civil Engineers, London, in which it is stated that an 18-in. centrifugal pump will work well with a 20-ft. lift, and a 36-in. pump will do the same with a 30-ft. lift. There is nothing in the context to explain this, and perhaps need not be. It is not explainable.

In the same connection is a table in which the diameter of the wheels or impellers is given as a measure of capacity. For example, an impeller 12 in. diameter will discharge 1,200 galls. a minute, and one 24 in. diameter 4,800 galls. a minute. These are examples of centrifugal-pump literature as it now exists, taken from Molesworth's Pocket Book, edition of 1893.

These proportions are almost without the pale of comment, and the same remark applies to a good deal besides, including a constant rule to lay out the curve of the vanes given irrespective of the head or speed, also the statement that the speed of small impellers in feet per second is $8\sqrt{H}$, and large ones $9.5\sqrt{H}$. As all these things will be referred to in remarks to follow they need not be criticised independently.

In other authorities are found tables of efficiency attained with concentric and volute chambers, giving such efficiencies as 1 to 1½; also the efficiency of vanes due to their form, varying from 20 to 40 per cent., without in either case including, or even mentioning, the head or the velocity of the impellers, but the strangest of all is in one case where the diameter of impellers is made a function of the diameter of the suction pipe or the inlet at the sides of the pump, the head, and consequently the speed of revolution, not being taken into account.

In "Hydraulic Power and Hydraulic Machinery," a recently issued work by Professor Henry Robinson, under the heading of "Centrifugal Pumps," is found the following:

"For raising large quantities of water a small height, a 'centrifugal pump' (which is practically an inverted turbine) is a very suitable form of pump. Appold constructed the first, and it has been the basis of all subsequent ones. In this form of motor it is necessary to bear in mind that the greatest efficiency can be only obtained when it is applied to work under a constant head. The calculations on which the shape and design of the motor are based show that an equally good result cannot be obtained when the head is variable. A velocity of about 5 ft. per second for the flow of the suction and discharge water is generally regarded as that which should be aimed at. The disk friction varies as the square of the diameter, and the loss due to total frictions increases as the cube of the velocity. Experiments with centrifugal pumps have established an efficiency of about 50 per cent. in the small pumps, and about 70 per cent. in the large pumps. The shape of the curved vanes of the fan materially affects the results, the best form being that in which these are bent backward."

These remarks we think will confirm what has been said about the literature of centrifugal pumps. The "inverted turbine" suggests carelessness of statement. There is scarcely any analogy between a centrifugal pump and a turbine, in so far as the forces at work in the two cases. The other propositions, including the invention of centrifugal pumps by Appold, will be considered in a future place.

One other circumstance of an introductory nature requires mention here. The intention was at first to republish, with revision and extension, the subject-matter of a series of articles written in 1886 for the *Mining and Scientific Press*, San Francisco, giving such facts as could be gathered respecting the

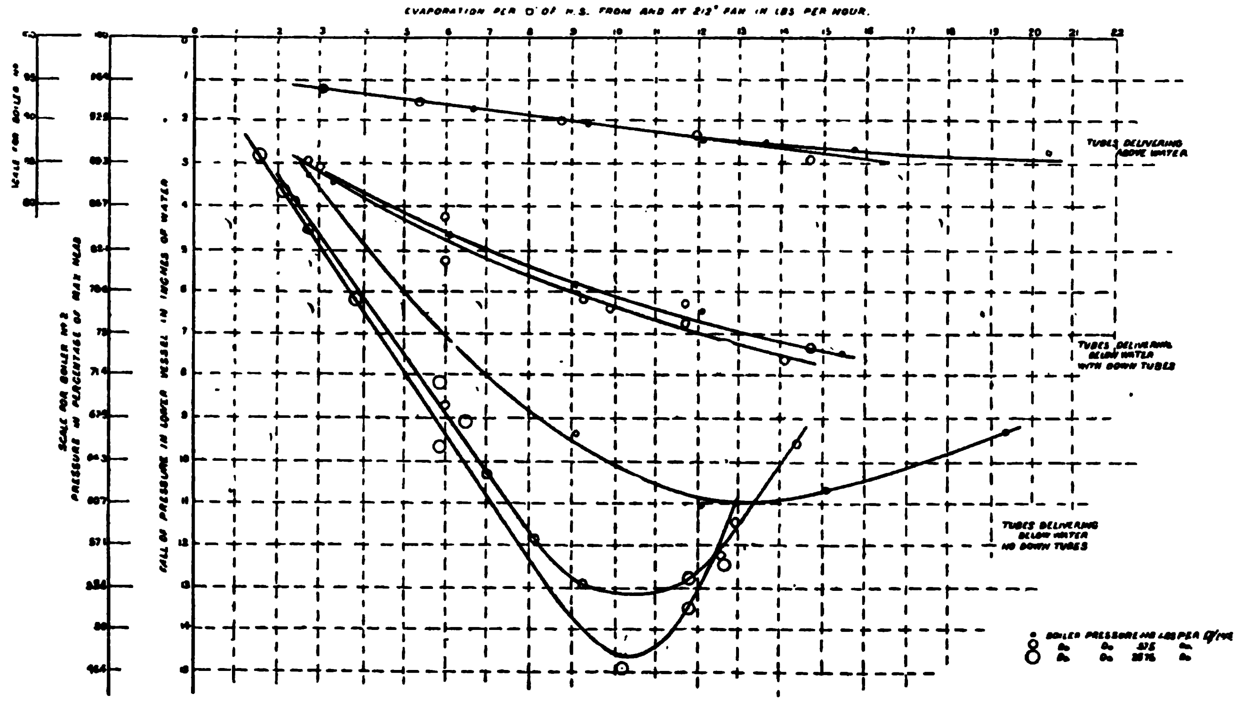


Fig. 3.

origin and history of centrifugal pumps. A second conclusion was that this matter would have increased interest if preceded with some explanation of these pumps, and the methods of their construction and operation for various purposes. This, as may be supposed, even in as condensed a form as possible, will greatly extend the space at first contemplated, but the importance of the subject warrants this, and even more than it is possible for the writer to include in such an essay at this time.

I.—CONSTRUCTIVE FEATURES.

In preparing designs for centrifugal pumps the first element to be considered is capacity, or the velocity and volume of water to be raised or forced. Velocity comes first, and is commonly less in the case of large pumps, where power is more considered, than for small ones. This is commonly arranged the same for both inlet and discharge ways in large pumps, and from 5 to 10 ft. per second, as the permanency of the duty may warrant. By this is meant that if only intermittent duty is required, as in irrigating and reclaiming land, there is a point where the interest on investment in the larger machinery and slower flow costs more than is gained by the avoidance of friction in larger machinery and a reduced velocity.

For this reason the velocity of flow in pump orifices is usually much increased over that in suction and delivery pipes when these latter are long. A desirable rate with small pumps of 6 to 12 in. bore is, for the inlet pipes, 5 to 6 ft. per second, and for the discharge pipes, 7 to 8 ft. per second. Between the inlet and discharge are the waterways of the pump. These are not at control and can follow no rule, as will appear further on.

The velocity or flow of the water in the suction and discharge ways of a pump being determined, the volume or capacity is next to be considered, and is easily found by simple computation expressed in gallons or cubic feet per minute. The next element to be determined is the diameter and number of revolutions of the wheel or impeller.

THE SIZE OF IMPELLERS.

The diameter of these will at first seem to depend upon the velocity of the radial flow between the vanes, so the water will make one revolution while in or around the impeller, the flow being uniform with that of the inlet and discharge ways, but here the designer is first called upon to disregard one of the laws of hydraulics and assume dimensions from a different standpoint.

The speed of the periphery of an impeller is governed by the law of acceleration for falling bodies, $V = \sqrt{2gH}$, or, expressed in feet per second, 8.025 times the square root of the head, commonly called for simplicity eight times the square root of the head. This circumferential velocity of the impellers will raise a column of water to the assumed head, but the additional pressure required for discharge or "flow" must be added, so it is common to estimate the velocity of impellers about 20 per cent. more, or $10\sqrt{H}$, which answers as a general rule, although the result is modified by the form of the vanes and the depth or width of the discharge chamber beyond the vane tips.

To proceed here by inference, or, as we may say, mathematically, the diameter of the impeller, or the number of its revolutions, as before mentioned, should depend upon the path of a particle of water through and around the impeller, and as this need not exceed 360°, or one revolution, there seems to be clear ground to proceed upon.

Assuming, for example, a head of 36 ft., then $10\sqrt{36} = 60$ ft. per second, or 3,600 ft. per minute, will be the velocity of the perimeter of the impeller, and if the pump is of 12 in. bore, and the wheel, as is common in practice, is 3 ft. in diameter, this will call for 382 revolutions per minute, which is a full limit for the endurance of the spindle bearings, in fact, is more than good practice will permit. If the diameter is made according to some rules given, twice that of the inlet pipe, then the number of revolutions would rise to 573 per minute, and the result would probably be a failure of the spindle bearings.

At the slower speed of 382 revolutions per minute for the impeller, and assuming the service flow in the pump orifices to be 7 ft. per second, or 420 ft. per minute, we find that if the water is to be carried through one revolution the radial flow will be, counting from the axis, at the rate of 573 ft. per minute, then the waterway through the impeller would be reduced about 8 per cent., and the velocity increased accordingly. Such an arrangement would cramp the inlet flow and cause obstruction to solid substances passing through the pump, so the section of the water ducts in the impeller have to be increased and the water carried through 500° to 800° of revolution, for mechanical reasons.

The discharge area at the periphery of the impellers, if made uniform with the outlet and inlet orifices of the pump, would be liable to clog, even in ordinary service, so this is usually made of double area, and the radial flow reduced to about 50 per cent. of its velocity in the inlet and discharge ways of the pump.

It will therefore be seen, unscientific as it may seem, that the diameter of the impellers of centrifugal pumps, and consequent size of casing, is based upon mechanical and operative reasons, and not on any hydraulic law. The safest way is to assume a limit of speed for the spindle-bearing surfaces not exceeding 350 ft. per minute, and from the revolutions thus obtained lay out the impeller accordingly. A good rule is to divide 1,000 by the diameter of the spindles in inches for the number of revolutions per minute; this will suit in all cases for water pumps.

The waterways of the pump, through the impeller and throat and elsewhere, must also be arranged to suit the nature of the duty to be performed. In some cases, as in dredging, for example, the velocity of the current may have to be reduced by enlargement of the throat to one-fourth what it is in the discharge nozzle or inlet to avoid danger of clogging.

PUMP CHAMBERS.

The bore or capacity, diameter, and speed of revolutions being determined, the next element is the casing or pump shell, and here again we meet with complexity. It was mentioned that one authority gave for volute shells an advantage of 20 per cent. in efficiency, which may be true, and less than true in some cases, but will not apply at all in other cases. The impelling power in centrifugal pumping consists of two separate forces, centrifugal force, and what is called tangential energy, or "mechanical push," due to the action of the vanes and force of discharge from the impeller, but these forces vary relatively with the head, and in such degree as to supplant each other at high and low heads, and on this circumstance depends the value of volute or spiral pump chambers or "casing," as they are commonly called.

Referring to fig. 1, it will be seen that the casing is in effect a portion of the discharge pipe, and may be thus considered, so a constant velocity of flow therein can be assumed for all heads. This being constant, and the tangential energy or velocity of discharge from the impeller being as the square root of the head, it is easy to see how rapidly the conditions change as these velocities are varied relatively. At a head of 40 ft. the tangential discharge will be 63 ft. per second, impinging on a body of water flowing at a tenth of this rate. This, expressed mathematically in terms of *vis viva* momentum and velocity, will show a considerable impulsive effect, for example: If M is the weight of the impinging water, and V its velocity; M' and V' the weight and velocity respectively of the water in the pump shell, and the lines of force are coincident, but the directions of flow are opposite, then

$$\frac{M M'}{M + M'}(V + V')^2 = \text{the inductive effect of the tangential}$$

energy. As a matter of fact, however, no such result takes place in practice; the angle of impingement is uncertain, depending on several circumstances, such as the velocity of radial flow, or width and form of the impeller, also the form of the vanes.

The thin stratum of water discharged at e, fig. 2, into the main discharge at a velocity ten times as great, disturbs and breaks up the solidity or normal flow in the discharge way, and, as experience proves, produces no useful effect that need be considered in designing pumps to operate against heads exceeding 40 to 50 ft. This statement, the writer feels called upon to explain, is based upon experience in dealing with heads from 40 to 100 ft. in a large number of cases where tangential energy was provided for, and in other cases where it was disregarded—that is, concentric and volute casing gave the same result. This may be called one extreme.

Proceeding now to the other extreme, for low heads of 2 to 5 ft., there is found a wholly different set of conditions, modifying the form of the pump chambers, and various other features of a constructive nature. For constant low heads, such as occur frequently in draining operations, there is a complete change of conditions, so much so that centrifugal force as an impelling force may be disregarded.

For low heads the velocity of the impeller or the vanes need not follow the rules before laid down. For heads from 2 to 5 ft. it will be as follows: $10\sqrt{2} = 14$ ft.; $10\sqrt{3} = 17.3$ ft.; $10\sqrt{4} = 20$ ft., and $10\sqrt{5} = 22.3$ ft. per second. With these low heads it is not necessary or expedient to limit the discharge flow to 8 ft. per second. This could be raised to correspond

with the velocities above noted, but should not exceed 12 ft. A pump under these conditions becomes an impact or "pushing" machine, corresponding to and almost identical with what is called a scroll impact water wheel reversed, the action comparable also to common water-lifting wheels, such as are employed at New Orleans and in Europe generally, for low and nearly invariable heads.

There is also the problem whether there should be any free or discharge space beyond the tips of the vanes except a discharge-way carried off tangentially, as in fig. 3. In this case, taken from actual practice, for a head of 3½ ft, the centrifugal action was almost entirely ignored, the impeller fitting close in a concentric chamber and the blades curved forward instead of backward. The inlet *a* was 50 per cent. greater in area than the outlet *s*, and the section of the latter, as well as that of the main chamber, rectangular. The pumps were vertical, submerged, and arranged to work through a bulkhead, *c*, no valves or pipes being required. The result fully confirmed the hypothetical reasoning on which the scheme was based—namely: That under the circumstances the circumferential velocity, or the vane velocity, would correspond very nearly to the discharge flow.

The writer has employed the same method with success for river dredging pumps where the head was but little, being only the difference between the river's surface and the point of discharge. The advantages gained by such construction for pumping stones or other solids are very important, and more than compensate for any loss of efficiency, such as may occur.

The impact of the vanes against bowlders or stones is avoided when the vanes are moving at nearly the same speed as the discharge flow, and solid substances are not thrown out violently against the casing as in the case of a common centrifugal pump. There is also an avoidance of clogging, which is almost sure to occur with a volute chamber, by solids becoming lodged or wedged in between the vanes and the case; also much loss of the abrasive effect of gravel or sand discharged radially that with a common pump will cut through the shell in a week or two of continuous service. Here we have another wide infraction of all rules laid down for pumps of this class, a disregard of nearly all the features that apply to water pumps for heads of 10 ft. or more.

The efficiency of a pump made in the manner shown in fig. 3, or with a concentric chamber, the vanes curved either forward or backward as the relation between their speed and that of the discharge flow may demand, is from 40 to 50 per cent., as nearly as observations in practice can determine.

VOLUTE PUMP CHAMBERS.

The next element to be considered in centrifugal pump construction is the section and shape of a volute chamber when the conditions of service demand that form—that is, for heads from 5 to 40 ft. or perhaps 50 ft.

A theoretical form of the volute or spiral casing should, to maintain uniform velocity of the discharge water, begin at nothing, and gradually expand to the discharge bore for a finish, but here again we are compelled to abandon the theoretical road because of certain operating conditions.

Referring to fig. 4, which is a diagram showing a theoretical volute chamber such as is employed by a good many makers of such pumps, it seems correct, but there is no provision for radial or outward flow for some distance at *a*, consequently the water contained and flowing between the vanes is checked in its course once on each revolution, while passing this point.

The writer made this mistake in 1883 in designing a pump to raise the surface drainage in the City of Sacramento. The pump is yet in use, giving a fair efficiency after ten years of service, but it developed a queer phenomenon that remained for some time a problem for which no clew could be found. The pump, when started, set up a series of rhythmic pulsations, causing vibration of the timber supports on which it stood that made it disagreeable to stand near the machinery. The first impression was that the impeller was not balanced, but it was soon discovered that the frequency of the vibrations or pulsations did not correspond to the revolutions, but to the revolutions multiplied into the number of vanes, and it will be no disparagement to admit that the real cause was not understood for some years later when other experiments proved where the difficulty lay.

Since that time the writer has in all designs for water-raising pumps of this class began the volute at *n*, fig. 1, with one-fourth to one-sixth the area or section it has at the discharge *a*, thereby sacrificing a considerable portion of the tangential energy, and causing an accelerated flow in the casing. This necessity for space in the discharge chamber at *n*, and the throat or cut-off plate *s*, is well understood. Messrs. Gwynne, of London, have always arranged their pump chambers in this manner. The cut-off or baffling plate *s* will be considered in a future place.

The nearness with which the vanes approach the volute chamber, or the radial depth at *s*, fig. 2, does not seem to be a matter of importance in a pump's operation, but regulates a constructive matter of some importance—namely, whether the pump chamber has to be parted through its axis to insert the impeller, or whether this be done through removable side plates, as in figs. 1 and 2.

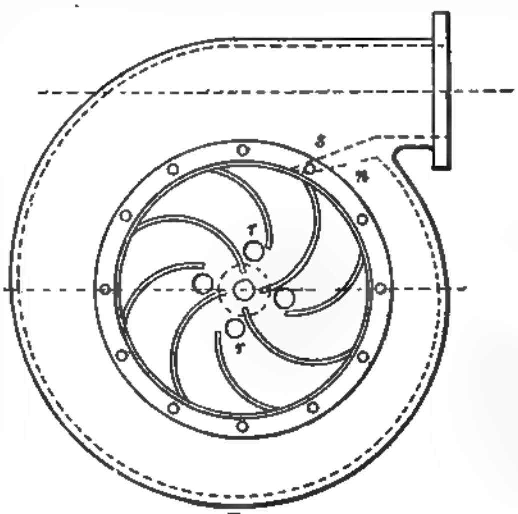


Fig. 1.

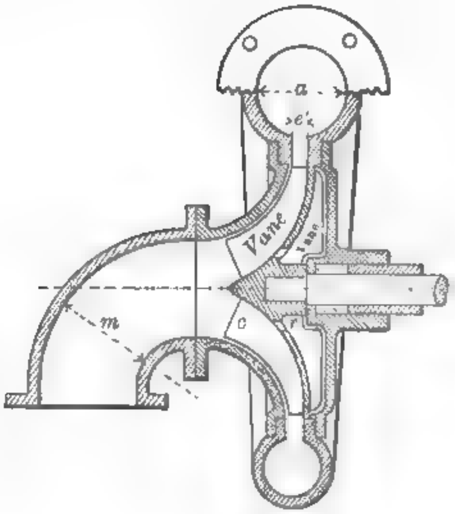


Fig. 2.

In the latter case a pump chamber can be cast in one piece, and erected so the discharge will be at any angle, the side plates, inlet and spindle bearings remaining undisturbed. This method has been a characteristic of the practice of Messrs. J. & H. Gwynne, above referred to, and is certainly desirable in nearly all cases, the exception being when there is no room at the side to remove the impeller, and when the shaft must pass through the pump, as in the case of circulating pumps for condensing water on board ships. Convenience and symmetry favor the solid volute casing with removable side plates.

THE VANE CHAMBER.

The tapering form given to these chambers is an attempt to maintain uniform area and consequent velocity of the water in its radial flow from the inlet. This is a rule of hydraulics, the violation of which causes a considerable loss of power if not observed, and brings us again to a point where centrifugal pump construction must diverge from theory.

Referring back to fig. 2, and supposing the dimension *m* to be 30 in., the area will be 707 in., and to maintain a uniform velocity of the water this section must be maintained out to and through the throat *e*. For an impeller 60 in. in diameter the perimeter will be 188.4 in.; this divided into 707.8 gives a width of 3 76 in., which is too narrow if any kind of débris, such as grass, roots, or driftwood, is to be passed through the pump This difficulty increases with the diameter of the impellers until at a head of 50 ft. the area should be double that of the inlet *m*, and for higher heads in proportion, especially when encased impellers are employed, as will be explained in a future place.

The curves in the water-ways in fig. 2 are supposed to be as perfect as can be attained, and are taken from designs made by the writer in 1886, for the Westinghouse Machine Company, of Pittsburgh, Pa, also for Messrs. W. T. Garratt & Co., of San Francisco.

IMPELLERS OR WHEELS.

These are made in three forms: with open vanes only; with

a disk or side plate open on one side, as in figs. 1 and 2; and encased or with two side plates, as in fig. 5. There is also a type having hollow arms that set the water around them in revolution, and thus avoid circulation back through the inlet, as will be further explained in future.

The function of the impeller being to set the water in revolution, its construction in respect to efficiency is not a matter of much importance, but there is a vast difference in the conditions under which pumps operate with open and encased impellers. Leaving out for the present the plate form with vanes on one side, and considering the open and encased forms only, the difference is one that would never be supposed from inference.

With the open form the whole mass of water within the pump is set in revolution, and the surface friction is between this mass of water and the side plates.

With the encased form the water within the impeller is set in revolution, and the surface friction is between its outer surface and the stratum of water between it and the side plates. The water friction is just the same in the two cases, and is always as the area of sides of the pump chamber, but there is this difference as to construction. The surface over which the whirling water flows must be true and without deviation in a radial plane, so that with an open impeller the side plates should be turned true on the inside, and with an encased impeller its exterior surface should be turned true.

The object of encased wheels or impellers is mainly to secure strength, which is vastly increased by this form, and is necessary at high speeds or for high heads, but there are operating conditions to provide for that considerably complicate the method and are open to objection. With an encased impeller the whole interior of a pump chamber is subjected to a static pressure equal to the discharge head, and this demands heavy side plates of ribbed section, and even then with high heads flexure is almost unavoidable.

In the case of what are called pit pumps in California, one of which is shown in section at fig. 5, the head is often 60 ft. or more, sometimes reaching 80 and 90 ft. At 60 ft. the pressure is about 26 lbs. per square inch. The impellers are 30 in. or more in diameter, and the sides of the pump case, including the discharge volute, when that form is employed, will make up a diameter of 42 in., and area of 1,385 in., sustaining under a head of 60 ft. a static pressure of 36,000 lbs., or 18 tons of internal strain on each side, so that a pump chamber not well ribbed will expand under such a force and be broken. At lower heads, and with larger pumps, this difficulty is less, but remains a factor to be carefully taken into account in designing centrifugal pumps of all kinds.

reached almost to the periphery of the impeller, which was 40 in. in diameter.

In another case a small pump having an impeller 20 in. in diameter was sold to a miner to be carried into the mountains and employed to raise water 110 ft. He was informed that the side plates were only ⅜ in. thick, and the pump would certainly burst. He replied laconically that "the pump was as heavy as he wanted to transport on a mule, and if it burst he could mend it." A letter from him informed the maker that the pump was "all right."

This difference in internal pressure between open and encased

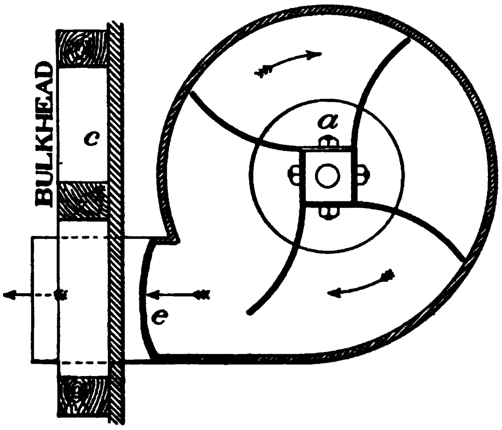


Fig. 3.

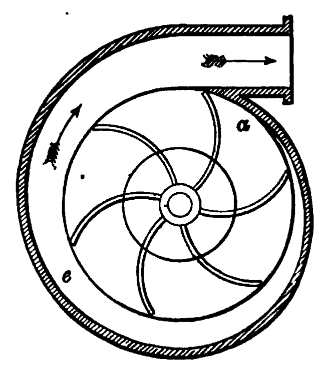


Fig. 4.

impellers is of course modified by revolution of the stratum of water between an encased impeller and the side plates, and as no additional friction would result it would be an improvement no doubt to employ shallow vanes on the outside of such impellers, so as to set the water in revolution against the side plates. This would not only relieve the latter of most of the discharge pressure, but would meet and prevent what is a serious objection to encased impellers, that of loss by circulation. With an encased impeller of any kind having no vanes on the outside there must be a running joint around the inlet nozzle, maintained against the discharge pressure. This can be explained by referring to fig. 5.

Supposing the inlet *a a* to sustain a negative or inward pressure due to a suction head of 20 ft., or 8.6 lbs. per inch, and the discharge throat of the impeller *e* subjected to a discharge pressure of 40 ft., or 16.2 lbs. per inch, then as no water joint can be maintained around the periphery of the impeller, the space at its sides, above and below, will be filled at this same pressure of 16.2 lbs., which, if added to the negative or inward pressure of 8.6 lbs., produces a force of 24.8 lbs. per inch, tending to circulate the water through the running joint at the inlet nozzle of the impeller. Whatever water can pass here, and it is commonly a good deal, is only circulated in the pump, and represents lost work.

The writer in his practice has usually employed several ledges or collars and grooves to obstruct such flow, and ended up with the abandonment of encased impellers, except when a fibrous packing around the nozzle could be employed. With clear water, where no grit or sand is present, these running joints can be maintained tolerably close, but this loss by circulation is always a matter of uncertainty, and not observable or even ascertainable after a pump is once erected except by an obvious loss of efficiency. Unquestionably the best way is to have vanes on the outside of an encased impeller, so as to cause revolution of the water there. As before remarked, there is no difference between the friction of the water against the side plates of the pump and the friction against the sides of the impeller. It is the same thing when the surfaces are alike in the two cases.

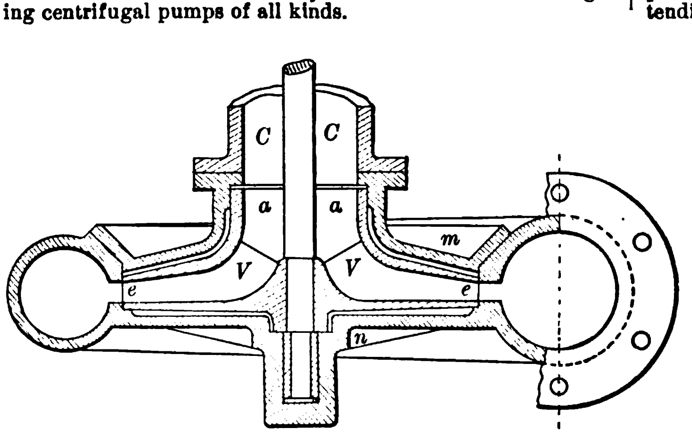


Fig. 5.

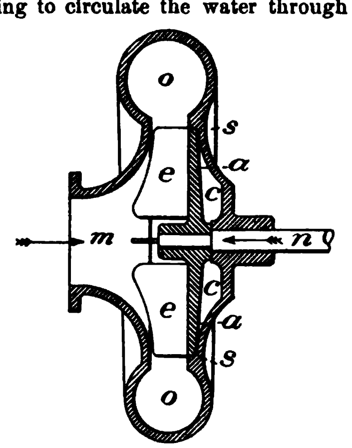


Fig. 6.

If the impeller is open the pressure on the side plates is in a large degree removed, because at the center of the pump, or over the inlet area, there is not only no internal pressure, but a negative or inward pressure, a partial vacuum, which gradually, and in some ratio not understood, changes to outward pressure, from the inlet to the discharge chamber. Theoretically such change of pressure would be a constant increase, but in an experiment made some years ago, holes were drilled through side plates at distances of three inches or so from the inlet pipe outward, and no water was discharged until it

BALANCING CENTRIFUGAL PUMPS.

We have now reached the most interesting problem in centrifugal pump construction—that of balancing the lateral thrust upon the impellers. It is a matter that modifies nearly all the constructive features of practice, and is, by any fair standard of comparison, one of the most intricate problems in hydraulic apparatus.

Some years ago, during some experiments at the University of California, Professor F. G. Hesse discovered the force developed on disks having different degrees of centrifugal action on each side, and prepared an essay on what he called a "hydraulic step" to resist weight or thrust, explaining the forces by formulæ. This paper was widely circulated and remarked upon by Professor Unwin and others. At the same time, however, this method of balancing weight and thrust was in practical use in California, for sustaining the weight of shafts in pits, but without Professor Hesse's knowledge, having been discovered in practical working.

To illustrate the nature and amount of lateral thrust on the disk form of impellers for pumps, and referring to the diagram, fig. 6, suppose the inlet at *m* to be 12 in. diameter, and have an area of 113 in., and that the head to be operated against is 40 ft., also that the impeller disk *a* on the shaft *n* is 36 in. in diameter and provided on one side with a series of vanes *e*. The pressure in the discharge chamber will be 17.2 lbs. per inch static, or in operating at least 18 lbs. per inch.

To find the unbalanced pressure and inward pull on the shaft *n*, the difference of pressure on the two sides of the plate *a* is not an easy matter. On the front or vane side there is the impingement of the entering water against the plate, which if curved, as in fig. 2, would amount to but little, certainly not more than 100 lbs. for a flow of 6 to 8 ft. a second.

There is also the increasing outward pressure from the inlet outward, due to centrifugal force, but, as remarked in a previous place, the amount of this force is not known, but it certainly does not exceed one fourth of the exposed area multiplied into the discharge pressure. Deducting the area of the inlet leaves 598 in. of area for the disk on this side, which, if multiplied by one fourth the discharge pressure, gives 2,668 lbs., and, adding for impingement, 2768.5 lbs. for the front or vane side.

On the rear side of the plate *a* toward the chamber *c c*, if there is no rotation of the water, there is, by reason of the water passing over the rim at *s*, a pressure equal to the discharge over the whole surface, except the area of the shaft *n*. This pressure or thrust will be $706.8 \times 18 = 12722.4$ lbs., or, less the area of a shaft 3 in. diameter, 12,596 lbs., from which must be deducted the counterbalancing pressure of 2768.5 lbs. on the front side, leaving unbalanced the enormous force of 9953.9 lbs. This is an extreme case, assumed for the purpose of illustration. No one at all acquainted with the matter would think of designing a pump in this manner, unless this lateral thrust was required for some purpose. It cannot be safely resisted by thrust collars of any kind, even when these are under water.

It is not an easy matter to determine when an impell r is not balanced, or the amount of lateral thrust upon it. It must be remembered, however, that it is always in proportion to the field of water rotation on the two sides, and this naturally leads to the conclusion that a pump should have an inlet at each side. This would be correct if it were not possible to balance the centrifugal action on each side without double inlets, and in this manner secure not only complete equilibrium, but also attain other important advantages of both construction and operation. It is not always desirable to balance centrifugal pumps; on the contrary, the lateral thrust on the impellers becomes essential in some cases, as will be explained further on.

In deep pits, such as are common in the irrigated districts of California, the pumps have to be set 40 to 50 ft. below the surface in order to be within suction distance of the water. Such pumps, from 4 to 6 in. bore, are driven by vertical shafts extending up to the surface where the driving power is applied. The shafts are commonly 2¼ in. diameter, and weigh with the couplings and fittings at least 20 lbs. per foot, or for 50 ft. 1,000 lbs. These shafts with the impeller of the pump, to operate well, must be balanced by water thrust, which in the case of disk impellers is provided in a very ingenious manner, shown in fig. 7.

The water enters on the top around the shaft *m*. The impeller disk *a* is provided with working vanes *e* on top, and balancing vanes *c* on the bottom, the latter enough shorter than the top ones to produce a modified centrifugal action beneath the plate, and this difference when adjusted is made to sustain the weight of the shaft *m* and all of its connected parts, weighing from 800 to 1,600 lbs. If the up thrust or balancing is not enough the impeller is taken out, and the ends of the bottom vanes trimmed off at *n* until an equilibrium is obtained. The bottom vanes *c* are commonly one-third shorter than the top ones *e* when the disks are 24 to 30 in. diameter, and it is surprising to see what an effect is produced by cutting off even half an inch from the ends of the vanes at *n*. This method of balancing disk impellers for centrifugal pumps is also applied to encased impellers, as in the case of pumps illustrated in fig. 5, and is shown in its most complete form applied to a horizontal pump in fig. 2.

It will be noticed there are vanes on both sides of the disk, those on the back being to set up there the same centrifugal action and force that exists on the front or working side. It will also be noticed that the back or balancing vanes are a little shorter than the front ones, commonly from ⅛ in. to ¼ in. for pumps to 10 in. bore. This slight difference in the length of the vanes, or the diameter over their tips, permits a slight excess of pressure on the front or working side,* and consequently a slow flow of water over the periphery of the disk into the chamber behind; some small holes *r* being provided for circulation. If the rear or balancing vanes were as long as the main ones, and centrifugal action the same on each side, the rear chamber would become partially or wholly filled with air, and the equilibrium destroyed.

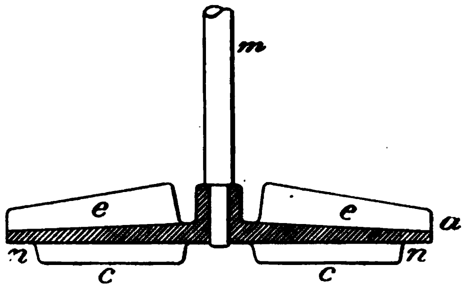


Fig. 7.

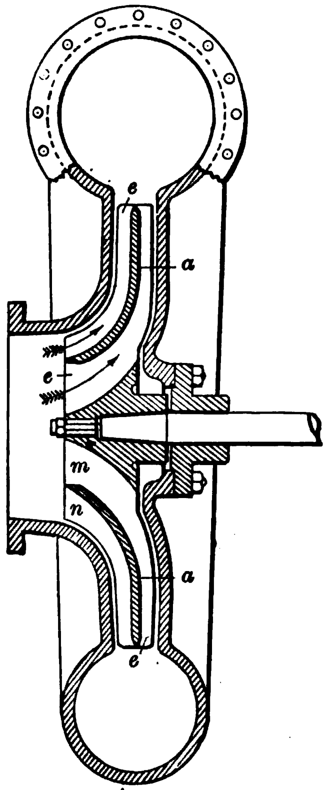


Fig. 8.

This method of balancing the lateral thrust on disk impellers was first applied by the writer in 1886, and is believed to be more reliable than double inlets. It may be described as providing for equal centrifugal action on each side of the plate or disk, but performing the whole work of propulsion on one side.

Attention is called to the curves and course of the water through the pump shown in fig. 2. Such easy curves are not attainable in double-inlet pumps, but very nearly so in another method of balancing plate or disk impellers next to be explained.

This method, shown in fig. 8, is one of recent invention, and apparently the most complete that has been discovered. It consists, as can be seen, in receiving the water at one side of the pump, thereby attaining the several advantages of that method already pointed out, and has the same balancing effect that is attained by a double inlet, but avoids the short curves and consequent obstruction that seems inseparable from the double-inlet method; also avoids placing the shaft or spindle through the inlet pipe or pipes. The water passes in equal volume on each side of a disk or web, *a*, the outer and inner annulus *m* and *n* being equal in area. The curves are easy and the construction strong, because the disk or web *a* acts as a continuous brace between the vanes *e*.

The distinction from the method of balancing last described is not only in the manner of operating, but also in the construction of the impeller itself. In the present case the vanes rise out of the boss or hub the same as with an open impeller,

the disk *a* forming only a web or brace for the vanes. In fig. 3 the disk itself is the main member, the vanes being set thereon in the form of ribs.

BALANCING ENCASED IMPELLERS.

When the impellers of centrifugal pumps are encased, as shown in fig 5, the compensation of lateral thrust is an easier problem in one respect, and a much more difficult one in another respect. The unbalanced area is only that of the inlet *a* less the area of the driving shaft's section, and the up-thrust in this case is as these areas taken with the discharge pressure, but there is the difficulty in all forms of encased impellers of maintaining running joints that permit waste by circulation.

Supposing the pump shown in fig. 5, which is repeated here for convenience of reference, to be constructed to operate against a head of 75 ft.; to be of 6 in. bore, and have an impeller 30 in. in diameter, and the weight of the shaft and other parts to be balanced 1,500 lbs. These proportions follow average practice for pit pumps in California, and the type as drawn is from designs by the writer made in 1886. The discharge pressure, counting 5 ft. of head for flow or friction, will be 34.4 lbs. per inch. Dividing the gravity load by this pressure gives about 85 in. of unbalanced area required to sustain the vertical load. This calls for an inlet area 11.2 in. diameter, which, taken over the outside of the impeller nozzle at *a*, gives a bore of 9¼ in., an average inlet for a 6-in. pump of this kind.

It is a circumstance worthy of note that with pit pumps of the kind here illustrated the thrust due to an inlet nozzle of the proper size will balance a shaft of the required dimensions to transmit the power, the increment of weight for the shaft and increment of pressure due to head following in the same proportion.

Fig 9.

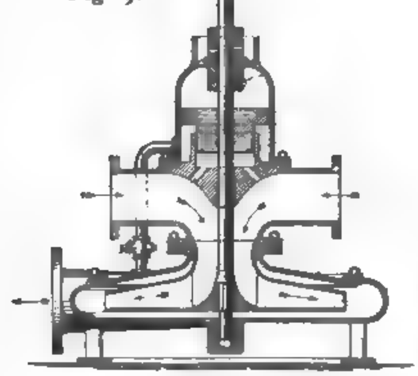
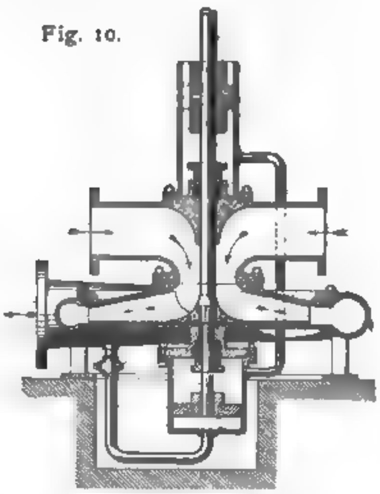


Fig. 10.



In the case of horizontal pumps with encased impellers, and an inlet at one side only, the thrust cannot be compensated by weight as in vertical pumps, and is attained in several ways; for example: by leaving the center around the shaft open, by a balancing plate opposite to the inlet, or by revolving hydraulic pistons on the pump shaft subjected to pressure from the discharge water.

Since the above was written there has been received from Mr. G. W. Price, of San Francisco, some particulars of a method of balancing impellers by means of pistons, as above mentioned, that has the advantage of ready adjustment for varying heads and speed, and is applicable to pumps of any kind.

The drawings in figs. 9 and 10 are taken from the patent specification of Mr. Price, fig. 9 showing a balancing or thrust piston placed above the pump, and in fig. 10 placed beneath the pump, the force of the pistons being upward in both cases, and receiving pressure from the discharge-way by means of connecting pipes as shown. As there is unavoidably a leak of water around these pistons, it follows that the pressure on them can be regulated by adjustable cocks in the supply pipes.

In fig. 9 the piston is compound, receiving pressure from the discharge way on an annulus, and a counter-force for adjustment from the suction acting on the central piston. As, however, pistons thus mounted on the pump spindle and fitting in fixed cylinders are subject to wear, Mr. Price has adopted a "floating" cylinder for the balancing piston, as shown in fig. 11, which is a vertical section through the main bearing and balancing piston as now applied to a number of pumps by the San Francisco Tool Company. In this case it will be seen that the balancing piston fits into a short cylinder capable of lateral movement in case the pump spindle and piston do not run true. The pipe below connects to the pump discharge, and the one above carries off waste water that passes the piston and does not find its way out through the spindle bearing, which is in this manner flooded with water.

In pumps having encased impellers there must always be, as before remarked, a good deal of loss by reason of water escaping or circulating around inlet nozzles. Whatever escapes over the periphery of the impeller flows back to the inlet and is forced through there with the whole pressure due to the discharge head.

The safest way is to place shallow vanes on the exterior sides of the impellers, and set up centrifugal action against the sideplates of the pump. This will prevent back flow and circulation without any loss whatever if the side plates are true on the inside. An encased impeller of any form must either set the water in revolution at its sides, or else have running joints to maintain against back flow and circulation. This the writer knows is not a commonly accepted fact, or understood by makers of centrifugal pumps, but accounts, no doubt, for the very uniform practice in Europe of employing open or disk impellers. Balancing by double inlets will be noticed in a future place.

THE FORM OF VANES.

There has been frequent complaint of the failure to derive useful facts, or suggestion even, from the literature such as exists on the subject of centrifugal pumps. Such complaint must continue. In a work on pumps, now lying at hand, there is a table to show the increased efficiency attained by Appold with curved vanes. "These experiments of Appold," the author remarks, "showed that the efficiency of a pump mainly depends on the form of the blades of the fan." A table shows that radial flat vanes gave an efficiency of 24 per cent., angular flat vanes 48 per cent., and curved vanes 65 per cent., the head being 18 ft.

It is hard to conceive what the circumstances were under which such results were obtained, unless it was within what may be called the flow limit. For example, a certain number of revolutions will raise the water to a given head, and 10 to 15 per cent. of added speed will cause a normal flow. The form of the vanes may have a good deal to do with this in so far as modifying speed owing to the friction of the vane tips and some other causes. The results stated must have been

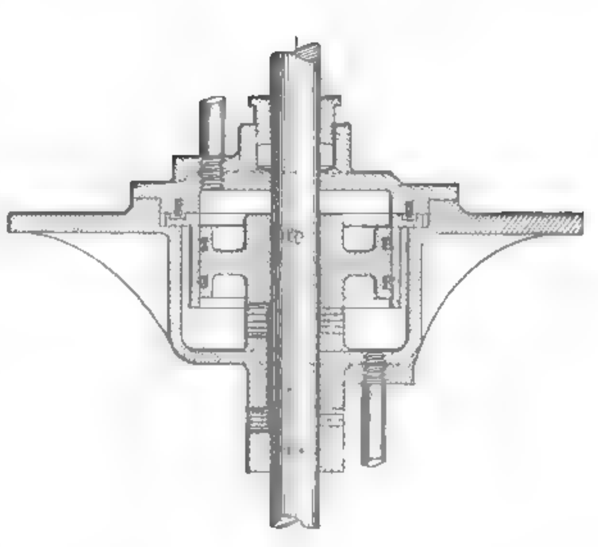


Fig. 11.

caused by not adapting the speed of the vanes to their form, otherwise there is no alternative but to call them nonsense.

This Appold experiment, and some others of the kind as well, give wrong inferences to those not able to understand the nature of forces at work, and have led to a widespread opinion that the form of the vanes is a very important matter,

whereas experience, as well as rational inference and analysis, must show that aside from the dragging friction of the vane tips their form is in common designs a matter of no consequence, or of little consequence.

In a pump operating under heads from 10 to 50 ft., where the tangential energy is a considerable factor in the effect, the vanes should conform as nearly as possible to the flow of water from the center to the periphery of the impeller, but divergence from this is, as before said, of little consequence.

The function of the vanes is to set the water in revolution, and at heads exceeding 40 ft., is but little more; the most important matter being the drag or friction of their tips on the discharge water in the pump chamber beyond the vanes. To make this understood it will be necessary to again refer to the velocities of the impeller and discharge water around it. The discharge flow is constant, and arranged at from 5 to 10 ft. per second, commonly about 8 ft. At a head of 50 ft. the velocity of the impeller will be about 50 ft. per second, or compared to the discharge flow, more than six times as great, so the tips of the vanes in every 50 ft. of movement must drag 40 ft. over the discharge water. This friction is a frequent source of loss in centrifugal pumps, and in one experiment tried by the writer showed that 25 per cent. of the power applied was consumed by retardation thus caused.

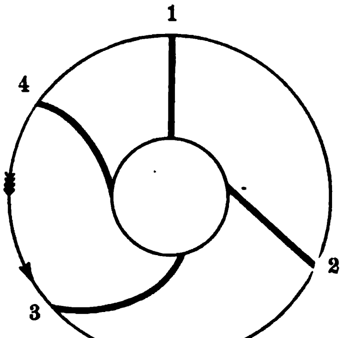


Fig. 12.

This is a reason for reducing the dimension e in fig. 2 to its lowest limits, narrowing the tips of the vanes and reducing the friction accordingly, but the point to be presented here is that as the head and velocity of the impeller increases, the vanes should be narrower at their tips and terminate more tangentially. The tips are, in fact, all that need be considered. These should change from a curve forward for low heads, as shown in fig. 3, to a true tangent, or as nearly that as possible for heads of 40 ft. or more.

To show the absurdity of imputing efficiency to a form of impeller vanes, one need go no further than the practice of Messrs. J. & H. Gwynne, of London, and of Mr Charles Brown, of Sulzer Bros., Winterthur, Switzerland. Drawings of the vanes designed by Mr. Brown, shown in fig. 12, are taken from a communication by him to *Engineering*, London, about eight years ago, and which we reproduce as follows:

To the Editor of Engineering:

SIR: The explanation given by your correspondent in No. 1,602 of the reason why the circumferential velocity of centrifugal pumps does not need to attain the value $\sqrt{2gh}$ may be one reason, but not the only one. About 1856 I carried out a series of experiments to determine the best forms and proportions of centrifugal pumps, and found that the form of the blades had a very great influence on the circumferential speed required. The annexed sketch, fig. 12, shows the forms of vanes experimented on; the total lift was in all cases 45 ft., the inner and the outer diameters of the disks as 1 and 3. To hold the water at this height, but without any discharge:

No. 1 required just $\sqrt{2gh}$.
No. 2 " considerably more.
No. 3 " still more.
No. 4 " $0.82 \times \sqrt{2gh}$.

No. 4 form was the best in every respect, and I continued to use it from the time the experiments were made to the present day.

C. BROWN.

The first clause of this communication furnishes the secret of the Appold tables before referred to, and the whole indicates the value that can be placed on the form of vanes. One would be at a loss to refer to any higher authority than the able engineer above quoted, and to suppose that Messrs. Sulzer Bros., one of the most eminent firms in the world, would construct centrifugal pumps of low efficiency is not supposable at all.

The writer in his own practice has not made experiments to determine the efficiency and speed resulting from vanes of different forms, and has never considered it necessary to do so. It is one thing in centrifugal pump construction that seems to be within easy and rational analysis. The main thing, and that which has led to the many absurd statements, is the change required in circumferential velocity by the form of the vanes and the effect of dragging action on the discharge water by vanes not terminating in a proper shape where pumps are to operate against high heads.

CUT-OFF OR BAFFLING VANES.

By this term is meant the web or vane shows at s in fig. 1. These have also been set up as an important element governing the efficiency of centrifugal pumps, in fact, almost everything has been so considered except the paint on the outside, and the wonder is that this has not been included among the factors relating to pump performance.

The value of these cut-off plates, which in the Parson's experiments showed an effect equal to one third of the duty, is sufficiently indicated by the fact that one of the principal makers on this coast, who has constructed a great many successful pumps of all sizes, discards this cut-off vane altogether. Like the form of vanes it is one thing that admits of rational treatment, in so far that such cut-off plates can do no harm. Tangential energy, which these plates or throats are supposed to intercept and direct, does not take place at the point of discharge any more than at other points around the impeller, and the main function is to propel the "slip" between the impeller and discharge water to take place in a line close around the periphery, instead of in a volute path.

As has been frequently pointed out, the circumferential velocity of an impeller is much greater than that of the discharge water around the impeller. At a head of 25 ft. this difference is as one to five, or thereabout, and the "slipping" velocity is four-fifths that of the impeller. The cut-off vanes determine the situation radially of this line of slip, and whether it takes place at the tip of the blades in one circle, or whether it takes place in what may be called volute strata, between the impeller and discharge water, can only be a matter of immaterial difference. It is best to employ such vanes, for the following reasons: It meets common opinion as to the best form of construction. It can do no harm, and makes a strong tie or connection between the side plates at that point. The following circumstance is the nearest to decisive experiment that can be referred to.

The writer in 1885 designed for a San Francisco firm a dredging pump to be employed in lifting silt from the bay and sending it ashore in long pipes. The pump casing was of rectangular section around the impeller, volute in form and terminated at the discharge with a throat or passage of 6 in. clear of the vanes. The engineer of the firm insisted on having a cut-off plate, which was made of steel ½ in. thick, and set in at a proper angle, and to clear the vanes by ½ in. The pump was arranged with an open gauge pipe 16 ft. high, by means of which the discharge friction head could be observed with precision. The man in charge of the machinery was informed that the throat piece or cut-off would probably "go out" as soon as a bowlder or some scrap iron went through the pump, and in that case he was to observe the speed, friction head, and any change in the operation of the pump.

The dredging operations were being carried on in a place where a great deal of iron scrap had been unloaded from vessels, and it was but a short time when the cut-off throat was carried away, and sent out in the shore pipes. The man in charge, a good mechanic, and now a member of a well-known firm of hydraulic engineers in San Francisco, reported that no change could be detected in any way when the throat piece was knocked out, and he preferred having no obstruction of the kind in the pump again.

DOUBLE INLET PUMPS.

In treating upon the subject of balancing the impellers of centrifugal pumps, double inlets were not included among the means by which this could be accomplished, because this plan of construction involves a good deal besides balancing. There are a great many among both makers and users of such pumps who think there is no other way to operate an impeller in equilibrium except to make it symmetrical on each side of a pump, and provide a forked suction pipe with an inlet at each side. This opinion, which is after all not to be wondered at when the complexity of this balancing matter is considered, has been the cause, no doubt, of pumps being made with double inlets, against all the objections, mechanical and other, that applies to this system.

The objections to double or forked inlets are: 1. The impossibility of securing easy entering curves. 2. Inconvenience of access and expense of fitting. 3. The spindles passing through and obstructing the inlet pipes. 4. Inaccessibility of the suction pipe by reason of its being under the pump. 5. Reducing the inlet areas by dividing them into two parts with a sharp ledge to catch obstructions. 6. Preventing the discharge case from being set at various angles independent of

the suction pipes. To these objections can be added general complication and expense not required. In land drainage operations on the Pacific Coast, and presumably everywhere, double-inlet pumps are liable to obstruction by tule roots, bean straw, weeds and other kinds of débris that is unavoidably carried into the sumps.

In the case of double-inlet pumps where the suction pipes are separate, and constitute framing on which the pump chamber is supported, there is a considerable saving of material and several of the objections before named do not apply. There is the advantage for low heads of making the impeller much smaller in diameter, and this permits smaller dimensions in all parts, the general dimensions of centrifugal pumps being approximately as the square of the diameter of the fans or impellers.

As to balancing by a double inlet, this applies only to horizontal pumps, and, as has been explained, can be attained in other ways than by double inlets, at less expense, with easier curves and a more symmetrical construction.

CENTRIFUGAL DREDGING PUMPS.

One of the most successful applications of centrifugal pumps has been for dredging purposes, raising and impelling silt, sand and gravel from the bottom of rivers and harbors. This work has, to a great extent, been done with what may be called water pumps, such as have been heretofore described, but for successful working a very different type is required.

The casing should be rectangular so as to avoid to a considerable extent the friction of tenacious material, and to distribute the impingement from the impeller over a larger area, also to permit a detachable lining that is easily replaced. As an angular section for the pump chamber calls for an impeller of parallel width, there is, of course, some loss of efficiency, because of the change of velocity from the inlet to the discharge chamber, but in dredging, efficiency is not the first thing to be considered in designing centrifugal pumps. The main thing is endurance against accident and wear. The pump itself is but one element among a number that make up a dredging plant, and the main point is to keep all in constant operation.

In pumping silicious material that is heavy, especially fine sand, if a pump stops while the discharge pipes are filled with spoil, it settles on the bottom and packs so as to be difficult to dislodge. The main thing is to "keep going," and whatever tends to security in this direction is more important than a high efficiency of a pump. An open-vane impeller is preferable, because it affords no chance for the lodgment of stones, or other obstructions drawn in, also because the vanes can be made elastic, which is a very important matter, as it avoids danger of fracture when solids pass through.

The discharge-way should be at the bottom, so that solids will not have to be "thrown over" but may pass out as soon as clear from the vanes, also to avoid charging, which is an annoyance and causes delay. Steel or wrought iron is the most suitable material for dredging impellers. The writer has, in two cases, one for a pump of 200 H.P. and one for a pump of 400 H.P., used successfully five-vaned impellers of cast steel, but these are open to the objection of requiring complete renewal if worn or fractured, and it is proposed in future cases to employ plates of steel riveted to a square extension of the shaft, as shown in fig. 3, but with heavier proportions.

In river dredging, such as is carried on in the Clutha River, in New Zealand, the Murray River in Australia, and in the rivers of California, dredging pumps should be arranged with large catch chambers in the suction pipes, otherwise the pumps have to be arranged to pass without injury stones as large as will go through the pipes. This is possible, but produces a good deal of distortion in the design. In no case is there such ill adaptation of centrifugal pumps as for dredging, which is not to be wondered at perhaps, when practice is so diversified for common purposes.

EFFICIENCY OF CENTRIFUGAL PUMPS.

Under this head is to be noted the singular fact that the commercial efficiency of centrifugal pumps is continually considered in their sale, and stipulated for in contracts, while no such guarantee is expected or even inquired about in the case of piston-pumps of the trade types. The reason of this is, no doubt, mainly accidental, growing out of the new pumps being a kind of mysterious machine that can be driven within 20 per cent. of the working speed and produce no result.

Positive pumps of all kinds, or indeed all but centrifugal pumps, discharge water in proportion to their rate of motion, hence there is a distrust of efficiency in centrifugal pumps, not to be wondered at, when such a pump may be driven at nine-tenths of its normal speed and discharge no water at all. In most of the experiments that have been published, the main element of all, the speed of impellers, has not been varied and the results included. There is, in fact, no way of predetermining the speed of a centrifugal pump, except by the velocity of the discharged water, and changes of this velocity may greatly vary the working efficiency, or, as said, stop the work altogether.

The most careful and extended experiments for efficiency known to the writer have been those at Ferrari, Italy, where six large pumps of 42 in. bore have been tested for efficiency a number of times over a period of years, showing a result of about 65 per cent. of the engine power in water raised. Equal or better results have been attained with some of the recent plants for draining purposes erected here in California, and it is safe to assume that for large pumps and heads, not exceeding 20 ft., an efficiency of 70 per cent. should be realized from this time forward. For greater heads and smaller pumps the efficiency falls off for several reasons. The frictional surfaces of the pipes and waterways increase as their size is diminished, and the friction of impellers as the square of their diameter. One authority, before quoted, claims that the sum of resistances in centrifugal pumps increases as the cube of the velocity. What this may mean is not easy to discern. If velocity of the water is meant, an increase from 6 ft. to 8 ft. per second would call for 2.37 times as much power to raise a given amount of water, or an increase from 5 ft. to 10 ft. per second, which is within the working range of such pumps, would demand an increase of power as 8 to 1.

If, on the contrary, the velocity of the impeller is meant, this is as the square root of the head, and its cube root has no application supposable. For example, for heads of 9 and 36 ft., the square roots will be 3 and 6, or, converted to impeller velocity, 24 and 48 ft. per second respectively. The cubes of these quantities are 13,824 and 110,592, or 8 to 1.

The true factor of resistance is the head, or its resultant the velocity of the impeller, and a safe rule is to assume a possible efficiency of 65 per cent. for pumps of 12 in. and more in bore, and for heads of 20 ft. or less. For small pumps and heads from 20 to 100 ft., deduct 1 per cent. from efficiency for each 2¼ ft. of added head. This may not be scientific or mathematical, but it is very nearly true, which is the important point to be learned, and makers of centrifugal pumps will find it to accord with fair experiments. As the question may be asked, and properly too, how such a rule was arrived at, the answer is, by providing steam power to raise water for irrigating purposes in California, and for heads from 40 to 127 ft. There are at least one hundred plants of the kind in the Santa Clara Valley, where observations can be made to determine the consumption of power in proportion to the head of resistance. In this increase of frictional resistance lies the limitation of centrifugal pumping in respect to the head. In piston pumps frictional resistance increases but little with added head and pressure, being only that of flow and of machine bearings. But in centrifugal pumps friction at the sides and periphery of impellers increases in some proportion, as indicated. It is a matter not very well understood, and, so far as known, the only data to be referred to are the experiments of Professor F. G. Hesse, of the University of California, which will be referred to in his contribution before noted.

A head of 127 ft. is above mentioned. This is the highest that has been attempted, and is for raising water from wells at the city water works, San José, California. The limitation in this direction is not known, the present lifts being from water-bearing strata tolerably uniform in depth, and from which the water rises to within the distances named of the required discharge level.—*Industries.*

(TO BE CONTINUED.)

POLE AND ROPE CONSTRUCTION STAGING.

By James F. Hobart, Brooklyn, N. Y.

A form of staging well adapted for heavy construction work, such as brick, terra-cotta and small cut stone material, is illustrated by the accompanying engraving (fig. 1). This staging, or the framework thereof, is constructed entirely of poles and ropes. The former are of spruce, from 12 ft. to 50 ft. long, and are inside of 6 in. in diameter at the large end, and not less than 2½ in. in diameter at the top. Spruce poles are preferable in sections of the country to which they are indigenous. Spruce poles are light, stiff and strong. They are also comparatively cheap.

Well-dried pine saplings may be used for staging purposes, but they are not as strong as spruce, therefore the staging constructed of pine will not carry as great a load as when built of spruce. Yellow pine poles make an excellent stage, but the timber is much heavier than spruce, consequently the labor of building is greater. Ordinary white birch (gray birch) has been employed to advantage in localities where that wood

abounds. The resulting stage is very strong, but the wood is fully as heavy as yellow pine. In tropical countries, where bamboo abounds, a more desirable timber for "rope and pole" stagings could not be conceived.

The rope usually employed is "three-eighths" or "half-inch" hemp. Cotton rope is good; but Manilla rope seems to be avoided by the stage builder—this kind of rope, being harder, does not adapt itself to the work as readily as the softer varieties, which cling like a glove to the smoothest pole. If the staging is to stand for a long time, say several months before removal, tarred rope may be used to advantage. This kind of Manilla rope will "cling;" but if a rope is to be used in its natural state, choose one of the "soft" varieties mentioned above.

The staging illustrated by fig. 1 has not a nail in it, and the material, when removed, will be just as good for another stage as it was when new. There are no nails to pull out, break off

light work and for walls not very high. For high or heavy work girts should be lashed on at every staging

Another girt has been started, as shown at the upper left-hand corner of fig. 1. This girt will come about right to receive a set of ledgers after the wall has been built up by a double tier of the horses shown at the left. It is supposed that the stage to be built on the top girt terminates the height of this stage. It will not stand building to a greater height, because there will be nothing to stay the poles between the upper and lower girts after the planking has been removed from the second tier of ledgers. In order, then, to make this stage available for heavy work, every tier of ledgers must be supplied with a row of girt poles. Indeed, for the very heaviest work girt poles are lashed on for every second stage, using only one row of horses between.

Bracing may be applied when necessary, and the bracing may be lashed on and consist of poles of a smaller size if they

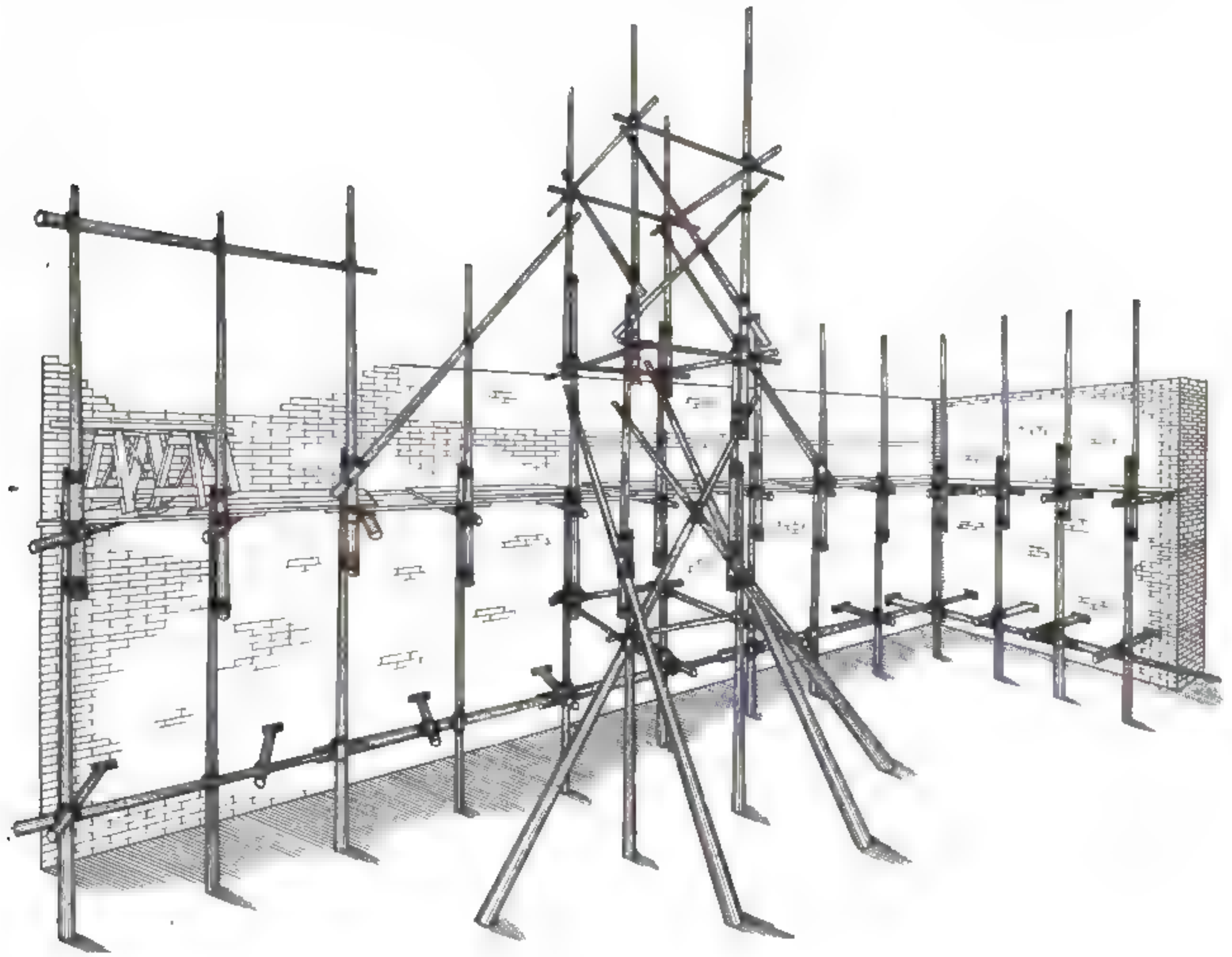


Fig. 1.

POLE AND ROPE CONSTRUCTION STAGING.

or to split the material, as is the case when the ledgers are made of boards or plank and nailed or spiked to the parts. As shown in the illustration, the staging consists of four parts beside the ropes—viz., the posts, girders, ledgers and flooring.

There are two good methods of erecting this form of staging, but one of which is shown in fig. 1; the other method consists of putting the first row of girt poles 8 ft. from the ground instead of 4 ft., as in the example illustrated. Either way is good, according to circumstances and material. In the example illustrated the poles are set into the ground about 6 in., merely to sustain them in a vertical position until the second row of ledgers has been put in place.

The method illustrated is preferable with short poles, but when long ones are to be used the wall may be built up about 8 ft. by the use of a double tier of horses and planking, then the first ledger poles knotted on at the right height to receive ledger poles for the third staging. That would bring the first row of girt poles up to where the second row of ledgers in fig. 1 are lashed directly to the post poles without the use of a girt. This method, shown by fig. 1, answers well for comparatively

are to be had. In general practice, however, the same size of pole is used alike for post, girt and brace. Near the center of the illustration a tower is shown, which was constructed to accommodate the "steam Irishman," or power hod-carrying device. The construction of the tower is very plainly shown in the engraving, and no description is necessary except to state that sometimes the pole girts of the tower are omitted and board girts nailed on instead. But there is no need of this, and the "all pole" tower can be made to fill the bill completely.

Usually but one brick is left out of the wall for each ledger, the small end of the short piece of pole being let into the wall, the larger end being lashed to the post. A thin wedge driven in on top of each ledger pole does away with any possibility of the pole's coming out of the wall It also stiffens the entire staging to a great extent. This staging may be extended to any required height within limits of the strength of the material used, and as soon as the staging gets high enough to enable the workman to reach the top of a pole, it should be spliced by holding up another pole and lashing it securely to the lower

pole. Three men are needed to do this—two to hold the pole in position and one to apply the rope.

A fastening like that shown by fig. 2 is the proper way to apply the rope. It will be seen that the fastening is commenced at the bottom, and ends at the top, where the end of the rope is fastened by tucking it down between the winding and the poles, then pulling the rope end tightly under the winding as shown. The beauty of this style of rope hitch is that heat, cold, rain or sunshine has no effect upon the holding power of the fastening. When the rope gets wet it simply shrinks a little, making the fastening all the tighter. When sunshine dries and stretches the ropes, the poles sag a very little, and this tightens the coils again at once. The effect of many weeks' exposure to alternation of temperature, moisture and dryness, is perhaps only to lower the upper stagings an inch or two at the most.

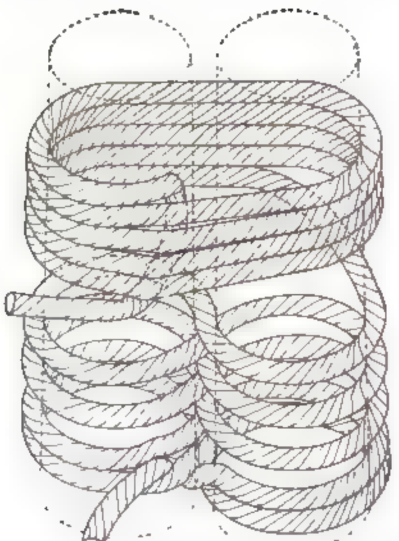


FIG 2
KNOT FOR SPLICING POSTS

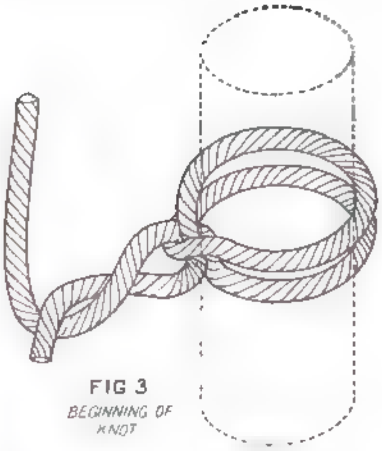


FIG 3
BEGINNING OF KNOT

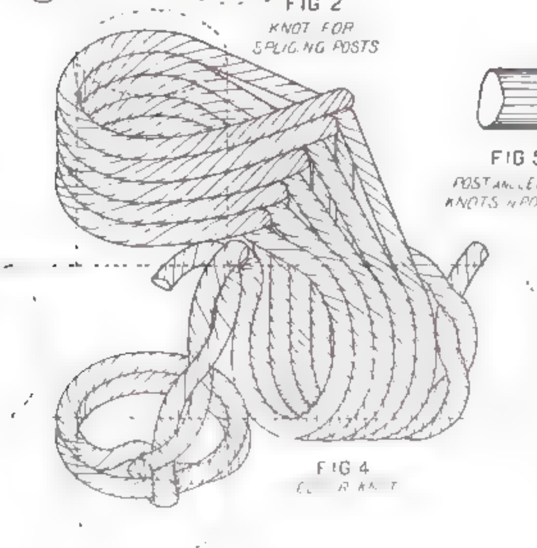


FIG 4

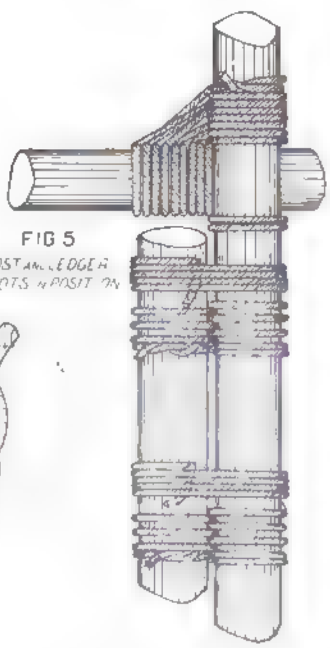


FIG 5
POST AND LEDGER KNOTS IN POSITION

It will be quite a task for the novice to put up a fastening like that illustrated by fig. 2. The first step is to make the hitch shown by fig. 3—something like the ordinary "timber hitch"—two complete turns of the rope being made around the top of the pole, and the ends of the rope being disposed of as shown in the engraving. The second pole, or "top-mast," is next placed in position and a turn of the rope taken around it, after which the rope is wound alternately around each pole until it carries from three to six turns (according to strength of stage desired), then the coils are passed around both poles, as shown in fig. 2, from four to eight turns being made and the rope's end fastened as above described.

For putting on a ledger pole, the hitch shown by fig. 4 is used. This is started in precisely the same manner that the vertical splice was commenced—the double-turn hitch being put on and the ledger pole *laid on top* of it. Next, one turn is taken around the ledger pole and the rope pulled very taut; the horizontal pole can roll in the rope, and a pull on the rope, accompanied by a twist on the pole by the assistant who is holding it in position, makes the rope strain up very tight. A turn of the rope around the post must next be taken, then a turn around the ledger, another around the post, and so on, alternating from one to the other until from five to ten turns have been put on, according to the requirements of strength, etc.

The girts should be attached to the posts in this manner and the ledgers made fast to the girts in a similar manner. When no girt is used, the ledger poles should be attached directly to the posts by the same kind of a knot. Indeed, it is only necessary to use the two hitches illustrated. The workmen are often tempted to make a simple hitch in fastening ledgers to girts, but don't do it. It is easy to wind the rope right around both poles without taking the "alternate" hitches shown by fig. 4; but a stage *cannot* be too well or strongly built, and the man who "scamps" work of this kind should be run out of the business.

Fig. 5 illustrates a completed vertical or post splice, and also shows the back or opposite side of the ledger or girt hitch (fig. 4 showing the front side of the knot, fig. 4 the back side). In putting on the rope lashings care must be taken that there is no loose bark to slip after the rope is in place. Knots or other rough parts should be trimmed smooth. If a girt or a ledger comes where there is a vertical or a horizontal splice, pay no attention to either, but put the rope lashing right over the hitch already made, just as if it was the middle of a single stick instead of a joint between two poles. Do the work thoroughly and no accident will ever happen on your job through failure of the construction staging.

THE AUXILIARY MACHINERY OF A MODERN CRUISER.*

By Frederick Arsenius.

While there is some difference in the amount and arrangement of auxiliary machinery in cruisers of the same class, the description of one will suffice for the whole class, and I have chosen for this sketch a cruiser which, through her wonderful speed performance a short time ago, is well known to everybody—the protected cruiser *Columbia*—the greatest triumph for our Navy Department and for her builders, William Cramp & Sons' Ship and Engine Building Company. It is astonishing what a number of different steam engines it takes to run one of these great ships, although they have a crew of a number that would seem sufficient to handle almost anything, yet there is such a variety of work to be performed constantly that modern practice is to depend on the crew mainly for the fighting part of the business, and to feed and regulate that mass of machinery which makes the ship inhabitable and gives it motion. To lift the heavy anchors, to hoist shot and shell, and to lift the ashes from the depths of the stokehold would be too slow a process if done by hand, and speed is now the motto. The systems of draining and pumping to keep the ships free from water, to feed the boilers and supply water for various purposes to different parts of the ships, and the electric lighting and ventilation must to a great extent be duplicated, so that no ordinary breakdown will disable the interior workings of the ships. Let us make a trip through the ship. Commencing down in the engine rooms we find, first, some parasites to the three colossal main engines (42, 59 and 92 in. × 42 in. stroke). One, the turning engine, consists of two vertical single-cylinder engines 8 in. diameter and 6 in. stroke. They have a common shaft with a worm in the middle, while

* Paper read at the Swedish Engineers' Club of Philadelphia.

through gearing turns the main shaft to a suitable position for starting. Another one is the reversing engine, a single upright cylinder 16 in. × 22 in. This has on top a hydraulic controlling cylinder, which can be used in case of breakdown, but which in ordinary running serves as an excellent guide for the piston-rod which acts through a lever on the high-pressure valve liners. Independent of the main engine stands in each of the three engine-rooms one air pump connected to the respective condensers. They are known as Blake's vertical "twin" air pumps, each having two steam cylinders 16 in. diameter, two air cylinders 31½ in. diameter, 21 in. stroke. They work slowly and steadily, about 16 double strokes per minute, and are remarkably economical, as they require only about ¼ of 1 per cent. of the total H.P.; they are very reliable, and need very little attention. Then in each engine-room are two circulating pumps for forcing cold water through the condenser, and also for discharging bilge water directly overboard. They are centrifugal pumps, each driven by a vertical single-cylinder engine, but they go in pairs and rest on the same bedplate. The pair can drive 14,000 galls. or 54 tons of water per minute through the condenser tubes, or pumps out the bilge at that rate in case of a leak. These pumps, as well as the turning and reversing engines, are furnished by the builders.

At the outside bulkhead in each engine-room is a double horizontal Blake pump. A fire, feed and bilge pump, with 12-in. steam cylinder, 8½-in. water cylinder, and 12 in. stroke. These pumps connect with the feed water tanks for feeding the boilers, with sea valves for pumping water into the fire main, also through valve boxes with the different drains for discharging bilge water overboard. Each engine-room has hanging on the dividing transverse bulkhead a Blake duplex vertical fire and bilge pump. Those in the forward engine-rooms are 12 in. × 7½ in. × 12 in., and in the after one 14 in. × 9 in. × 12 in. Their purpose is also to supply the fire main from the sea and to discharge outboard from valve-box connections with main and secondary drains, bilge, and water-bottom suctions. There are also on the same bulkhead three sets of pumps of the same make as the former, but much smaller, having 7½-in. steam, 4½-in. water cylinder and 10 in. stroke. They are called water service pumps, for their duty is to furnish a cold shower to the main journals, thrust bearings and other parts likely to be heated by running. They also supply the fire service. In the after engine-room is a Sturtevant blower or ventilating fan, 36 in. diameter and 17 in. wide, driven by a 3½ in. × 2½ in. double-enclosed engine of about 4 I.H.P. It will exhaust 8,000 cub. ft. of air per minute at 600 revolutions. Overhead in the two forward engine-rooms, right under the armor grating and nearly covered from sight by twisted masses of pipe, hang two Wheeler auxiliary condensers, really condensers for auxiliary machinery. They are 9 ft. long and 30 in. diameter, directly mounted upon combined air and circulating pumps, each having 12-in. steam cylinders, 10-in. air cylinders, 10-in. water cylinder and 12 in. stroke, which, running at 100 ft. piston travel, have a capacity of 400 galls. per minute each. In one boiler-room we find at its forward end on each side a large vertical Blake duplex pump, with two steam cylinders 12 in. diameter, two water cylinders 7½ in. and 12 in. stroke. On the starboard side is the main feed pump, which takes water from the tank feed pipe connecting with the feed tanks, and pumps it into the boilers at the rate of 500 galls. per minute. The one on the port side is the auxiliary feed pump, for while it has the same duty as the main feed pump, it has also valve-box connections with sea for supplying fire mains and flushing boilers, with main and secondary drains and bilge suctions, and for emptying boilers. They can discharge either upward through feed pipes to outboard delivery or down through a bottom valve. They are placed in each boiler-room, and there are eight in all. In each boiler-room are four large blowers, 16 in all, used to force air into the fire-room according to the closed stokehold forced-draft principle. They are 5 ft. diameter and 14 in. wide at outlet, driven by 5 in. × 4 in. double-enclosed engines, and are capable of delivering 25,000 cub. ft. of air per minute, with 4-oz. pressure and 650 revolutions, requiring about 37 I.H.P. each. They are, however, only expected to supply 240,000 cub. ft. per minute altogether, under a pressure of 1 in. of water. These, as well as all other blowers in the ships, are of the well-known Sturtevant make.

On the platform deck forward we find there first two small double-hoisting engines, 4½ in. × 4½ in., located in the passing room in the midst of magazines, and used to hoist powder and shell to the gun deck. Aft of the magazines, and forward of the boiler space, is the dynamo-room or electric light plant. The ship has an installation of about 512 lights, 16 and 50 candle-power, and search lights. The generating plant consists of two 32-kilowatt marine generators with attached dynamos, of the General Electric Company's make, having a speed of 400 revolutions, and supplying 400 ampères at a pressure of 80 volts. There are also two small electric fans 21 in. × 5 in. Aft of the engine-room on platform deck are two ammunition hoists, similar in design and size to the forward ones. After this we come across the immense steering engine—a double-cylinder horizontal engine 13 in. diameter × 10 in stroke. It is geared to a very large screw which works two nuts connected by rods to the secondary tiller, which again turns the main tiller on the compound lever principle. This steering engine can be worked from below protective decks, from bridge deck, pilot house, conning-tower, and flying bridges.

On the protective deck we come across a variety of blowers. Two of them, 4 ft. diameter, stand at the head of the forward engine hatch, draw the hot and foul air out of the engine-rooms, and blow it up through the ventilators; capacity, 9,000 cub. ft. The two donkey boiler-rooms and the distilling-room have each one blower about 3 ft. diameter, and they are needed to keep the air fresh. About midships on each side are embedded among the coal bunkers the ship's blower rooms, each containing two blowers 4 ft. diameter and 15 in. wide at the outlet, with 4 in. × 3 in. double-enclosed engines, capable of 600 revolutions and 10,000 cub. ft. per minute at a pressure of 2 oz. They are the heart and pulse of the ship's ventilation. They draw through the main ducts and pipes with their hundred of arms reaching into every coal bunker, every magazine, and every state-room above and below. They draw the vitiated air out, or, if necessary, can blow in fresh air. The two donkey boiler-rooms have each two pumps, small duplex vertical, 6 in. × 4½ in. × 7 in., one a main feed pump, the other an auxiliary feed pump.

The distilling-room is quite an interesting little museum of various steam pumps. One large horizontal single-cylinder is a circulating pump for the distiller, taking water from sea valve at bottom, and after forcing it through the distiller, discharges into the head. This is a Davidson pump 8 in. × 9 in. × 12 in., capable of 260 galls. at 100 revolutions. Another pump has two water cylinders 2¼ in. diameter, one steam cylinder 3½ in. diameter and a common stroke of 4 in. One end of this takes sea water from discharge of large pumps and feeds into the Baird evaporator. The other end takes the distilled water from the filters and delivers to the ship's tanks, and another small pump, single horizontal, 3½ in. × 2½ in. × 4 in., takes the drain from the traps and delivers it to the feed tanks. There stands also the large wrecking pumps, whose sole duty is to pump from connection with the main drain, directly overboard, water collecting in the lower compartments, which the other pumps are unable to handle. It is a Blake horizontal single-cylinder, 10 in. steam, 14 in. water and 18 in. stroke, and can at ordinary speed, through its 8-in. delivery pipe, force 840 galls. per minute. To finish this deck, there is an upright engine for driving the machine tools in the engineer's workshop.

Going up to the gun deck forward our attention is first called to a mass of 20 tons of machinery which we find to be a windlass, of the American Ship Windlass Company's make, generally known as the Providence windlass. It is driven by two vertical engines with 12-in. cylinder diameter and 14 in. stroke, built for 2½-in. chain and 10,000-lbs. anchors. It also drives a capstan located on the upper deck. On this deck are also located the ash hoists, which hang a few feet above the deck of the boiler-room and dividing bulkheads. They are double-cylinder engines 4½ in. × 4½ in., with a drum and reversing gear. They are very neat and clever, and can be worked from the upper or gun deck from either side as required. Williamson Brothers are the makers of these as well as all other hoists and the steering engine. There are eight of these ash hoists. On the upper deck is only one engine, and that is the Allen dense air ice machine. This consists of an air compressor 5¾ in. diameter × 10 in. stroke, which compresses air 60–210 lbs., and passes it into a cooler, which takes off the heat of compression, and thence into the expander, a regular cut-off machine, where the air is admitted during part of the stroke, then cut off, and the air is expanded as the stroke is finished. During this expansion the air is cooled to a very low temperature—practically 60° F. below zero. The return stroke pushes this cold air through the pipes that encircle the refrigerating-room and coils through the scuttle butt, and is then returned to the machine to go through the same process over and over again. The steam cylinder for driving is 7 in. diameter × 10 in. stroke, and uses 50 lbs. of steam. Above the deck is the bridge deck, and there stand two deck hoists 8 in. × 8 in. double-cylinder reversible engines. This finishes the steam machinery with the exception of engines for small boats standing on this deck. They are fitted with very complete but diminutive marine engines of the compound type, but these have of course their own steam generators. The 30-ft. cutter

has an engine 3¼ in. × 7 in. × 6 in. stroke; and the 33-ft. steam barge one 4 in. × 7 in. × 7 in. stroke.

In addition to steam machinery, one capstan is worked by hand, as are five 7-in. Calkin's deck pumps that draw from principal compartments in the hold, the valve boxes, the sea, and deliver it to the fire main or discharge overboard. There is also one 5¼ in. force pump to supply water to baths, cisterns, etc., and one 8-in. pump for fresh-water service; a number of small hand pumps, hand steering gear, and machinery for working the heavy guns.

Summing up, we find 39 steam pumps with 60 steam cylinders, 26 blowers or ventilating fans with 52 steam cylinders, 8 starting engines and 5 reversing engines, with 9 steam cylinders, 8 ash hoists with 16 steam cylinders, 4 ammunition hoists, 2 deck hoists, 1 steering engine, 1 windlass, 1 shop, 1 air and 2 electric light engines with 23 steam cylinders, making a total of 88 engines with 160 steam cylinders outside and separate from the 3 main engines with their 9 cylinders.

It takes, of course, a great deal of steam to run these auxiliary engines. From trial trips of the United States steamships *Philadelphia* and *San Francisco* I find that the auxiliary machinery took a little over 3 per cent. of the total I H.P., and that the proportion would give for this ship about 650 I H.P. But they are not all run at the same time; those running during the *Columbia's* trial trip took only about 600 I.H.P. This does not include the ship's or engine room blowers, no hoists of any kind, no distilling-room pumps, nor many others, so that if they are all working at the same time they would require 1,200 I H.P., which is as much as it takes to drive a steamer 254 ft. × 35 ft., and 2,800 tons, at a speed of 12.3 knots an hour. There are pumps enough to discharge 515,000 galls., or 193 tons of water per minute, and blowers enough to blow in or out 481,000 cub. ft. of air per minute.

Ticket-Selling on the North London Railway.—The *Engineer* says that the penny in the-slot system of selling tickets has been adopted by the North London Railway. The arrangement is for workmen's tickets only.

THE BEAUMONT-WALLINGTON HIGH-SPEED ENGINE.

One of the most interesting adaptations of the type of valve gear that is operated from the connecting-rod that we have ever seen was illustrated in a recent issue of the *Engineer* (London), to whom we are indebted for the engravings and description of the engine. The engine illustrated is of the single-acting description, with central valve contained in a hollow extension of the piston-rod, which is actuated by a new radial gear. The latter is also a new departure in this

FIG 1

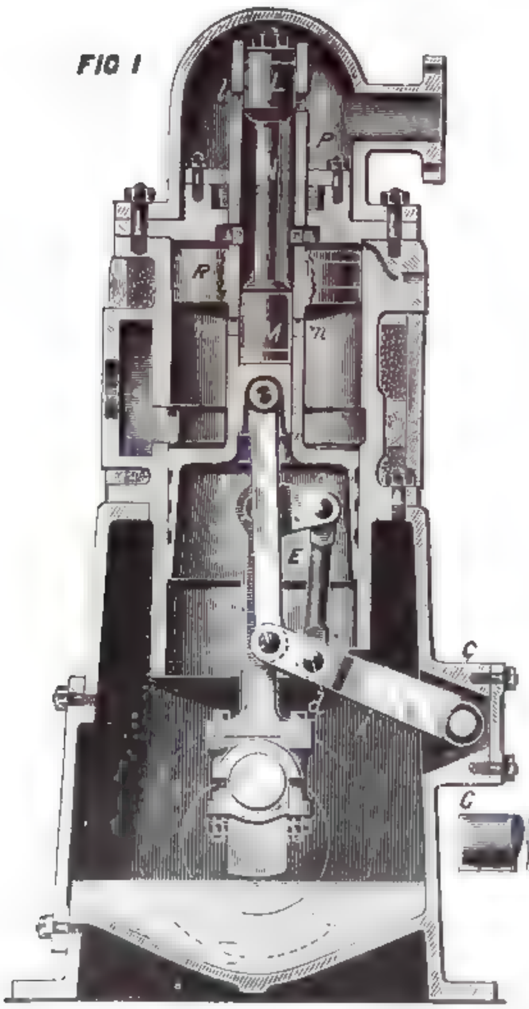
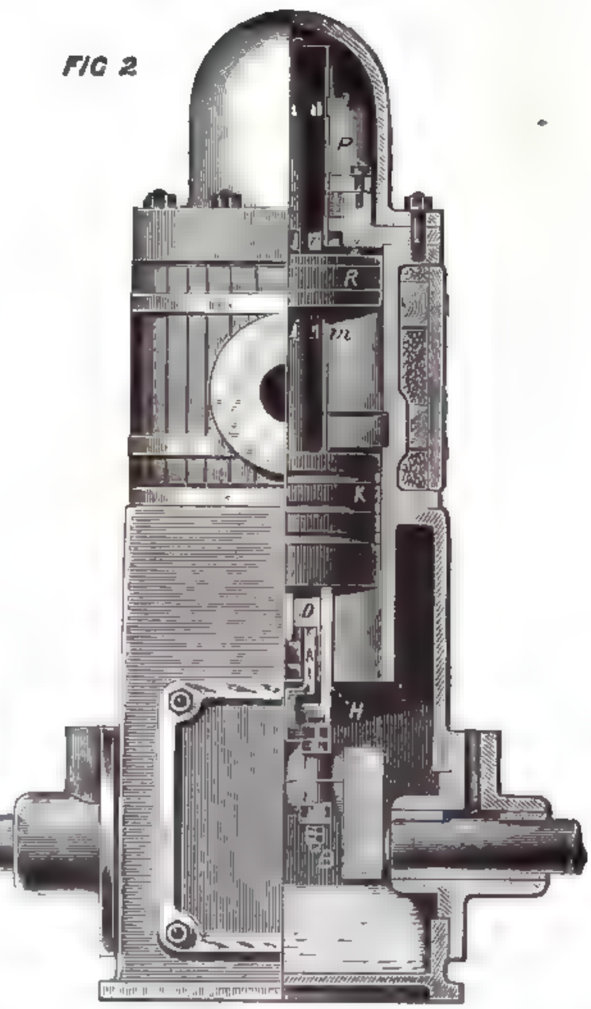


FIG 2



class of engine. This gear gives to the valve a motion which causes a very perfect distribution of steam in the cylinder. During one revolution of the crank there are four distinct movements of the valve: (1) A quick upward movement opening the valve for admission, (2) a quick downward motion performing cut-off; (3) a longer period of comparative slow movement during expansion; (4) another quick movement opening the exhaust port, which remains open till nearly the top of the return stroke, when it closes, forming the steam cushion. On referring to the illustration, it will be seen that the connecting-link *D* is attached to the extremity *c* of a vibrating lever, *A*; an intermediate point *d* in this lever is connected by a link, *E*, to a short arm, *G*, at right angles to, and forged solid with, the connecting-rod *H* at the cross-head end.

All the functions of lead, cut-off, expansion, exhaust and compression are performed thereby in a simple, quick and accurate manner. In order to show how this is attained, we may suppose the connecting-rod *H* to be disconnected from the crank-pin, and moved from its top position, as shown in the illustration, to the center of the stroke in a straight line, without swinging the lower end to either side; it is evident that the arm *G* would move down the same distance as the piston, consequently the intermediate point *d* on the lever *A* would also travel the same distance, but the extreme point *c* would move a greater distance; the difference of the distance

of the travel of these two points c and d respectively being equal to the lap and lead of the valve. Now, if the connecting-rod be swung to the right until it comes to its proper position in the crank circle, it is evident that the end of the lever G would move upward, carrying with it the link E, lever A and the valve-link D, together with the valve. The actual movement of the valve relatively with that of the piston in half a revolution is therefore equal to the difference between the travels of the points d and c, together with the motion imparted by means of the arm G. The amount of the steam-port opening is determined by the length of this arm together with the distance between d and c, and by varying these any degree of expansion can be obtained. It will be seen that the link D is always in compression with the link E in tension, so that any slight wear in the one is compensated by wear in the other. The gear is, therefore, self-adjusting.

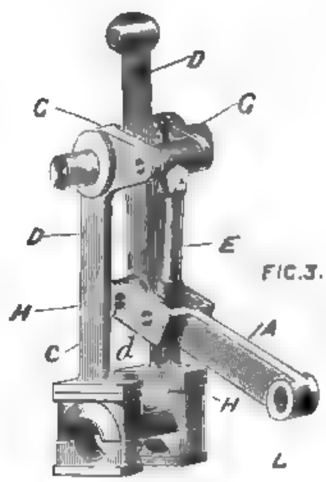


FIG. 3.

These engines are made either simple, compound or triple-expansion, with either one or two cranks. The cranks are of steel and the bearings of phosphor-bronze. The crank-chamber is closed, as shown in the engravings, and forms a receptacle for the lubricant, in which the crank revolves, as is usual in this class of engines. The engines are made under the patents of Messrs. Beaumont and Wallington by the Blair Engineering Company, Bellenden-road, Peckham, S. E.

COAL CONSUMPTION; EMPIRE STATE EXPRESS.

STATEMENT RELATIVE TO MILEAGE, SPEED AND FUEL CONSUMPTION OF THE NEW YORK CENTRAL & HUDSON RIVER RAILROAD CLASS N ENGINE, DRAWING THE EMPIRE STATE EXPRESS TRAIN IN JULY, 1894.

Weight of engine and tender in working order	91 tons.	0 cwt.*
Average weight of train, passenger, baggage and mail (exclusive of engine and tender)	186 "	10 "
Average weight of train, passenger, baggage and mail (including engine and tender)	277 "	10 "
Time schedule (deducting stops)	77 hrs	31 min.
Deduct time made up		79 "
Actual running time	76 "	12 "
Total train miles	3,848	
" light " (without cars)	26	
" mileage	3,874	
Average speed per hour	50 [illegible] miles.	
Total weight of coal consumed (exclusive of kindling)	53 tons.	6 cwt.*
Actual consumption per train mile	31 [illegible] lbs.	
Consumption per train mile (including kindling)	32 [illegible] "	
Total ton miles, including passenger, baggage and mail (exclusive of engine and tender)	717,504	
Total ton miles, including passenger, baggage and mail (including engine and tender)	1,067,968	
Consumption per mile per ton of train, including passenger, baggage and mail (exclusive of engine and tender)	2 [illegible] oz.	
Consumption per mile per ton of train, including passenger, baggage and mail (including engine and tender)	1 [illegible] oz.	

STATEMENT OF LIGHT TRIP (WITHOUT CARS) OF CLASS N ENGINE 999, BETWEEN ALBANY AND SYRACUSE AND RETURN, RUN ON SAME SCHEDULE TIME AS ABOVE.

Weight of engine and tender	91 tons.	0 cwt.
Total mileage	296	
" weight of coal consumed	1 ton.	14 cwt.
Actual consumption per mile	12 [illegible]	
Total ton miles, engine and tender	26,936	
Consumption per mile per ton	2 [illegible] oz.	

ANALYSIS OF COAL USED IN TEST

Water	.25
Volatile matter	32.01
Fixed carbon	62.96
Sulphur	.48
Ash	4.30
Total	100.00

*Tons of 2,240 lbs.

On July 24 the same engine referred to above ran from Syracuse to Albany, 148 miles, in 144 minutes, and stopped 3 minutes at Utica, making the average rate of speed while running 62.98 miles per hour. Between Utica and Albany it ran 95 miles in 90 minutes, or at the rate of 63.33 miles per hour. The run from Albany to New York, 142.88 miles, was made in 2 hours and 57 minutes. The train consisted of four cars.

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

THE object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publications will in time indicate some of the causes of accidents of this kind, and to help lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with the information which will help make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a great favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in July, has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS IN JULY.

Fort Scott, Kan., July 1.—A freight train on the Pittsburgh & Gulf Railroad ran into a stock train on the Fort Scott & Memphis Railroad at Last Chance Crossing this morning. The engine of the freight went over, and the fireman, Jack Dobbins, fell under the engine and was crushed to death.

Greenville, Me., July 1.—An express train on the Canadian Pacific Railroad was wrecked on a bridge near this place today. Engineer Fred Leavitt was killed, and Angus McDonald, fireman, fatally injured.

Pine Bluff, Ark., July 2.—A freight train on the St. Louis Southwestern Railway went through a trestle 2 miles south of New Louisville. Engineer Ferguson was killed outright and Fireman O'Neil fatally scalded. The trestle had been fired and burned nearly through.

Chicago, July 3.—A passenger train on the Baltimore & Ohio Railway was ditched at Rock Island Junction to-day by strikers. The engineer was badly hurt in jumping.

Pueblo, Col., July 2.—Engineer Loftus and his fireman, who were running on the Denver & Rio Grande Railroad, were hung by a mob south of here to day.

West Superior, Wis., July 6.—Strikers ditched a train on the Chicago, St. Paul, Minneapolis & Omaha Railroad tonight, derailing the engine and seriously injuring the engineer.

Ottumwa, Ia., July 7.—A passenger train on the Chicago, Fort Madison & Des Moines Railroad struck an obstruction this evening. The engine was ditched, killing the engineer and fireman.

New York, July 8.—The limited express on the New York Central & Hudson River Railroad struck a car door which had fallen from a south-bound train across the north-bound tracks, and the engine was derailed. The engine ran for some distance and finally struck an iron water tank; the engineer and fireman jumped before the engine struck the tank and escaped with slight injuries.

St. Louis, Mo., July 9.—An express on the Big Four Railroad ran into a freight train at Wann, Ill., to-night. Oliver Davis, the fireman, was fatally injured and the engineer seriously hurt. The freight train had not pulled on to the switch far enough to clear the main line.

Bethlehem, Pa., July 10.—The Buffalo Express on the Philadelphia & Reading Railroad was wrecked this evening by a misplaced switch. The engineer, Matthew Bickel, was fatally injured. Fireman James Hutchinson was seriously scalded, but in spite of this he pulled Bickel from the wreck and then drew the fire from the fire-box.

Sacramento, Cal., July 11.—A passenger train on the Southern Pacific Railway was derailed by strikers 3 miles from here to-day. Some timbers were loosened from the trestle, which caused the engine and two mail cars to go over. Engineer Samuel B. L. Clarke was killed.

Neosho, Mo., July 12.—A freight train on the Kansas City, Pittsburgh & Gulf Railroad was derailed 5 miles south of here to-day by an open switch. The engine was turned over and caught Engineer Traver under it, killing him instantly. Fireman Grant Grattis was badly scalded and cut.

LOCOMOTIVE RETURNS FOR THE MONTH OF MAY, 1894.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage.					Av. Train.		Coal Burned per Mile.						Cost per Locomotive Mile.							Cost per Car Mile.		Cost of Coal per Ton.
			Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Passenger Cars.	Freight Cars.	Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Passenger.	Freight.	
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Atchison, Topeka & Santa Fé	855				1,891,560	2,182,425	2,881						79.24			3.97	7.79	0.20	1.81	6.67	0.15	20.09			1.78
Canadian Pacific	603		491,010	509,775	414,468	1,415,253							64.25			2.19	9.99	0.33		5.64	1.28	19.43			3.18
Chic., Burlington & Quincy	541					1,416,246		4.90	19.12				85.03			4.06	7.64	0.16	0.18	6.84	0.04	18.92			1.81
Chic., Milwaukee & St. Paul		855				2,162,965							65.11			4.10	8.02	0.26		6.93		19.31			2.40, 2.50
Chic., Rock Island & Pacific			501,623	929,988	334,178	1,765,789																			
Chicago & Northwestern	1010		823,282	1,339,274	598,024	2,760,580	2,733						30.54			3.29	7.46	0.28		6.27	0.85	18.15			1.83
Cincinnati Southern																									
Cumberland & Penn.*	23	23	7,818	20,815		28,633	1,245						32.46			3.18	4.11	0.35			1.78	14.37			
Delaware, Lackawanna & W. Main L.																									
Morris & Essex Division	163		187,994	149,590	102,045	439,629	2,697						66.22			4.81	10.29	0.38		6.28		21.26			3.08
Flint & Père Marquette			89,708	65,005	61,783	216,491	2,488			50.00	66.66					3.356	5.275	0.18		5.20	0.852	14.81			1.71
Hannibal & St. Joseph	66	66	65,223	165,341	31,489	262,053	4,095	4.96	16.88				74.62	13.49	5.54	3.28	5.93	0.10	0.14	6.59	0.02	16.05			1.77
Kansas City, Ft. S. & Memphis	142		95,929	225,087	83,060	404,076	3,259						63.69			2.96	4.28	0.21	0.36	7.30		15.11			1.30
Kan. City, Mem. & Birm	41	37	34,929	39,697	9,329	83,955	2,268						61.01			4.42	3.24	0.24	0.31	7.00		15.21			1.04
Kan. City, St. Jo. & Council Bluffs	36	36	52,269	41,521	43,352	137,142	3,809	5.03	24.82				67.11	13.18	4.28	2.75	6.11	0.12	0.15	6.45	0.04	15.62			1.85
Lake Shore & Mich. Southern	593		423,783	660,441	367,869	1,452,093	2,448			56.72	86.21	38.97	64.59			3.30	4.57	0.05	0.12	6.75	0.16	14.95			1.41
Louisville & Nashville																									
Manhattan Elevated		298	779,647		68,857	848,504	3,817						37.68			2.60	7.60	0.20		9.00		19.40			4.02
Mexican Central	148	130				450,350							66.66			4.71	13.64	0.40		4.63					4.27
Minn., St. Paul & Sault Ste. Marie	104	77	79,188	88,932	38,871	206,991							56.96		4.20	2.79	8.31	0.23		6.47		17.80			2.87
Missouri Pacific	351					991,508	3,403	4.27	17.91				79.43			4.71	5.79	0.29	1.21	6.32	1.37	19.70	3.92	1.33	1.48
Mobile & Ohio	107	86	76,251	159,388	53,313	288,952	3,360		20.30				62.83			3.05	4.50	0.22	0.61	5.41	0.97	14.76			1.48
N. O. and Northeastern																									
N. Y., Lake Erie & Western		631	438,289	694,498	235,541	1,368,328				88.30	142.07	178.90		20.00	5.60	4.36	7.69	0.35	1.99	7.39	1.29	28.07			1.36
N. Y., N. H. & H., Old Colony Div			375,993	163,172	180,160	719,325		4.00	17.90				62.11	16.30	5.90	3.47	9.32	0.57		7.18	0.76	21.30			
N. Y., Pennsylvania & Ohio		276	181,827	122,351	314,978	569,156				59.80	114.4	182.30		11.40	5.50	4.08	5.05	0.29	2.57	6.99	1.24	20.17			1.11
Norfolk & Western, Gen. East. Div.†			98,750	312,098	49,678	460,526	2,774	5.12	21.18	46.28	120.48		88.38	9.00	5.70	6.51	3.53	0.29				10.83			3.30
General Western Division†			104,173	393,274	61,715	559,162	2,900	5.48	17.48	76.00	126.00		118.00	13.87	7.69	11.65	3.98	0.27				15.90			
Ohio and Mississippi																									
Philadelphia & Reading			436,399	272,731	762,487	1,471,617							81.07			4.78	4.75	0.23		5.80	0.47	16.03			
Southern Pacific, Pacific System	723	650	664,758	750,929	270,587	1,686,274	2,994	5.06	18.92				66.64			6.10	16.46	0.20	2.00	7.25	1.22	33.23			4.81 1/10
Union Pacific			509,023	905,794	333,851	1,748,168	3,967	6.15	18.89				97.04			9.62	9.80	0.40		8.01	1.22	29.05	4.23	2.03	2.01
Wabash	418	325	425,982	512,296	190,542	1,128,820	3,473	4.62	16.78	50.93	95.24	55.60	75.86	12.77	5.67	3.35	4.32	0.24		5.55	0.92	14.88	2.73	0.97	1.17
Wisconsin Central	149	108	136,382	155,491	80,362	372,235	3,444						71.97			2.58	3.31	0.16		6.34	0.75	18.14			2.29

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars. Empty cars which are reckoned as one loaded car are not given upon all of the official reports, from which the above table is compiled. The Union and Southern Pacific, and New York, New Haven & Hartford rate two empties as one loaded; the Kansas City, St. Joseph & Council Bluffs and Hannibal & St. Joseph Railroads rate three empties as two loaded; and the Missouri Pacific and the Wabash Railroads rate five empties as three loaded, so the average may be taken as practically two empties to one loaded.

* Switching engines allowed 6 miles per hour; wood, construction and gravel trains, 10 miles per hour.

† Wages of engineers and firemen not included in cost.

Terre Haute, Ind., July 12.—A passenger train on the Big Four Road was wrecked 10 miles east of here to-day. The engine was derailed and went into a ditch. Engineer Norman was killed. The disaster was caused by train wreckers.

Peoria, Ill., July 12.—A double-header freight train on the Toledo, Peoria & Western Road was ditched by running into a cow between Canton and Bushnell to-night. William Schwartz, one of the engineers, was killed, and John Quinlan, the other engineer, and William Schellbager and Ed. Beam, firemen, were injured.

Columbus, O., July 13.—An engine on a freight train on the Baltimore & Ohio Railroad jumped the track at Pan Handle Crossing this evening and rolled down a 10-ft. embankment; the engineer was caught underneath the engine and crushed. Fireman Thomas Carr was slightly injured.

Terre Haute, Ind., July 13.—The Big Four passenger train was wrecked at Fontainet by strikers this morning. Engineer Moorman and his fireman were killed.

Momence, Ill., July 13.—An express train on the Chicago & Eastern Illinois Railroad was wrecked here to-day by a misplaced switch. William H. Lunt, engineer, was seriously injured, and Fireman Albert Lester had his leg broken and shoulder dislocated.

Salida, Col., July 13.—A train on the Denver & Rio Grande Railroad was wrecked at Marshall Pass to-day. The engineer was fatally injured and the fireman seriously.

Lynn, Mass., July 13.—A passenger train on the Boston, Revere Beach & Lynn Railroad ran into a gravel train this afternoon. The engineer of the gravel train, Charles S. Reach, was thrown from his cab and injured about the head.

Louisville, Ky., July 14.—There was a head-end collision on the Louisville & Nashville Railroad at Colesburg to-night; both engines were badly wrecked. Engineer Frank Dudley was killed and Fireman Fay McCormick was slightly injured.

Easton, Pa., July 16.—A freight train on the Lehigh Valley Railroad ran into a gravel train at Kennedy to-day, and later a west-bound mixed train ran into the wreck. Robert Cline, engineer, and Samuel Filkenson, fireman, were seriously injured. The accident was due to the carelessness of a flag man.

Battle Creek, Mich., July 16.—A passenger train on the Grand Trunk Railroad was wrecked here this morning; the fireman was killed outright and the engineer was badly bruised about his face and head. The wreck was caused by the removal of fishplates from the rails, and it is said to have been done by strikers.

Mobile, Ala., July 17.—There was a rear-end collision between two freight trains on the Louisville & Nashville Railroad to-night, and the fireman had his leg crushed so that amputation was necessary.

Oakland, N. J., July 17.—A rear-end collision occurred by a passenger train running into a freight on the New York, Susquehanna & Western Railroad to-night. Engineer John Beatty was painfully injured by splinters of wood striking him in the face.

Clinton, Ind, July 18.—An engineer on the switching engine ran into a lot of coal cars on the Chicago & Eastern Illinois Railroad to-day. The fireman was the only one hurt.

Esperance, N. Y., July 19.—An express train on the Delaware & Hudson Canal Company's Railway ran into an open switch here to-day, striking several box cars on the side track. Fireman Palmer was killed and Engineer Truman Austin was fatally injured.

Macon, Ga., July 20.—A head-end collision occurred between a passenger and a freight train at Dame's Ferry on the East Tennessee, Virginia & Georgia Railroad here to-night. Fireman Pat Rogers and Doyle Thorn, engineer, were killed.

Leadville, Col., July 21.—While rounding a short curve here this morning Edward Malloy, a fireman on the Colorado Midland Railway, was thrown from his engine. His skull was fractured, and he was otherwise fatally injured.

Colorado Springs, Col., July 21.—A passenger train on the Atchison, Topeka & Santa Fé Railroad ran into a steer this morning; the engineer and fireman jumped and were slightly injured.

Norwich, Conn., July 22.—Dwight Beebe, fireman on a freight train of the New York & New England Railroad, was struck by another train to-day. His left hand was severed, his skull fractured and right arm broken; he died shortly afterward.

Texarkana, Tex., July 23.—There was a collision on the Texas Pacific Railway between two fast trains this morning. Edward Grimm, an engineer, and Allen, a fireman, were killed.

Sandusky, O., July 23.—A passenger train on the Colorado, Sandusky & Hocking Railroad collided with a switch engine to-day. John Van Horn, engineer of the passenger train, was killed.

North Bend, O., July 23.—The Chicago Express on the Big Four collided with a freight train at Griffiths this morning. The fireman of the freight engine was killed, and Engineer Differ, of the freight engine, was badly injured, as was also Frank Driver, engineer, and a fireman named Lampier.

Hantsport, N. S., July 23.—A collision occurred on the Windsor & Annapolis Railway between an excursion train and the special. Fred. Miller, an engineer, was injured in jumping from the engine, he had his face cut, his nose broken; fireman McNair was cut about the face and slightly injured about the head and shoulders.

Lima, O., July 23.—An attempt was made to wreck the pay train on the Cincinnati, Hamilton & Dayton Road to-day. The engine was partly wrecked and engineer Sweetman and fireman Kirchner badly injured. The work was done by running freight cars down on the main track.

Dunkirk, N. Y., July 23.—A special on the Dunkirk, Allegheny Valley & Pittsburgh Railroad ran into an open switch at Fredonia to-night and was wrecked. Fireman Keppell and Engineer Kimball jumped, the fireman sustaining serious injuries, while the engineer escaped with a sprained ankle and slight bruises.

White Cloud, Kan., July 24.—A freight train on the Chicago, Burlington & Quincy Railroad ran into a landslide at Gibraltar to-day. The engine tipped over and the engineer was slightly injured by having his fingers cut.

Pittsburgh Pa., July 25.—Spreading of the rails in the yards of the Edgar Thompson Steel Works at Braddock caused an engine and cars belonging to the Carnegie Company to be derailed. Fireman McCauley and Engineer John McCauley were seriously injured.

Lafayette, Ind., July 26.—A collision occurred between two trains on the Wabash Railroad 4 miles from here to-night. Engineer Clarke and Fireman Brown jumped; the engineer was fatally injured, the fireman seriously.

Ashland, Wis., July 27.—The relief train on the Wisconsin Central Road for the sufferers of the forest fires was burned to-day. Both engineer and fireman were injured.

Portage, Wis., July 27.—A passenger train on the Wisconsin Railroad collided with a switch engine here to-day. Engineer O. L. Blanchard was badly bruised.

St. Paul, Minn., July 27.—A freight transfer on the Chicago, Milwaukee & St. Paul Railroad was side-tracked near Mendotta to-night. The engineer and fireman were immediately attacked by strikers, though neither were seriously hurt.

Dansville, Ill., July 28.—Jo Burns, an engineer on the Chicago & Eastern Illinois Railroad, was shot this afternoon by strikers. He was shot through the lungs, and died from the effects of the wound.

Columbus, O., July 28.—Two Hocking Valley engines collided on account of a misplaced switch to-night Engineer Thomas Burke was caught and badly injured.

Chattanooga, Tenn., July 29.—Engineer John Lynch, on the Queen & Crescent Line, saw an open switch just ahead of him while running a fast mail train to-night; he stuck to his train and saved it. The fireman jumped and was badly injured. The switch was misplaced by train wreckers.

Cincinnati, O., July 30.—An express train on the Baltimore & Ohio Southwestern ran into a freight train 2 miles west of Aurora, Ind., this afternoon. The engineer and fireman of the passenger train were killed.

Cochran, Ind., July 30.—An express train on the Ohio and Mississippi Railway ran into a freight train here to-night. John Little, engineer of the passenger train, was fatally injured; Daniel Cadden was also caught in the wreck and lost a leg.

Ithaca, N. Y., July 30.—A loaded coal train on the Lehigh Valley Railroad collided with a passenger train near here to-day. Engineer Hawkins was badly hurt and Fireman C. B. Minor instantly killed.

Columbus, O., July 30.—A serious freight wreck occurred in the Columbus, Hocking Valley & Toledo Yards to-day by a switch having been left open, causing two engines to jump the track. Tom Burke, one of the engineers, was painfully injured.

Field, B. C., July 30.—The boiler of the locomotive on the Canadian Pacific Railway freight train exploded on a grade near here to-night. Engineer Wheatley and Fireman Hunt were killed.

Our report for July, it will be seen, includes 50 accidents, in which 21 engineers and 15 firemen were killed, and 25 engineers and 25 firemen were injured. The causes of the accidents may be classified as follows:

Boiler explosion	1
Cattle on track	2
Collisions	19
Derailments	1
Falling from engine	1

Killed by strikers	2
Landslide	1
Misplaced switch	6
Obstruction on track	2
Rails spreading	1
Struck by train	1
Train burned	1
Train wreckers	9
Trestle burned	1
Unknown	2
Total	50

PROCEEDINGS OF SOCIETIES.

Association of Engineers of Virginia, at the midsummer meeting, held on July 14, Mr. Staples gave a talk on the construction of the canals connecting the head waters of the Wisconsin and those of the Illinois rivers. The special feature of the work is the entire use of concrete masonry in the walls, locks, etc., which were put in at a cost averaging about $8 per yard.

Master Car & Locomotive Painters' Association.—The twenty-fifth annual convention of the Master Car & Locomotive Painters' Association will be held at Buffalo, N. Y., on the 12th, 13th and 14th of this month, convening at 10 o'clock A.M., on Wednesday the 12th. The headquarters of the Association will be at the Genesee Hotel, where thorough arrangements have been made for all in attendance. The following are the lists of subjects that will be presented in the papers and discussed: 1. What is the best method of keeping accounts in the paint shop? Labor and material? 2. What methods and materials produce best results in repainting passenger cars that are badly cracked, and is there any method by which cracks in old paint can be obliterated without burning off? 3. In adopting a classification of repairs to passenger cars, what are the various conditions of the paint or surface that should determine the class of repairs, or what standard can be adopted by which to determine when the condition of the paint requires a certain class of repairs? 4. An essay on Painting Passenger Cars, in the form of questions and answers. 5. What is the best method of computation and establishing rates for piece-work on the different classes of painting repairs for passenger equipment cars? 6. What is the best method of computation and establishing rates for piece-work on the different classes of painting repairs for locomotives? 7. What is the best method to adopt to insure the proper care of and prevent loss of paint shop tools—namely, brushes, chamois skins, sponges, dusters, buckets, cups, etc.? 8. What advantages if any are there in using ready prepared primers and surfacers on cars and locomotives in preference to those prepared from our own formulas, convenience, time and durability considered? 9 What primers and surfacers, or formulas for the same, which do not contain white lead, have proven satisfactory substitutes for lead primers and surfacers on the outside of passenger cars and locomotives? 10. What style of finish in the construction of passenger equipment cars is the most desirable from a painter's standpoint—namely, the easiest painted or cleaned and kept in repair, durability and economy considered? The panel sliding with battens, or a 2 or 2½-in. beaded or tongue and groove sliding.

PERSONALS.

The following appointments have recently been made on the Great Northern Railway Line: Mr. C. H. Jenks, Superintendent Northern Division, vice C. C. Ponsonby, transferred. Mr. O. O. Winter, Superintendent Willmar Division. Mr. Winter will also continue in charge of the Breckenridge Division as Acting Superintendent until further notice. Mr. C. H. Cannon is hereby appointed Superintendent of Car Service.

Mr. D. McLaren is appointed General Superintendent of the Montana Central Railway and operated lines.

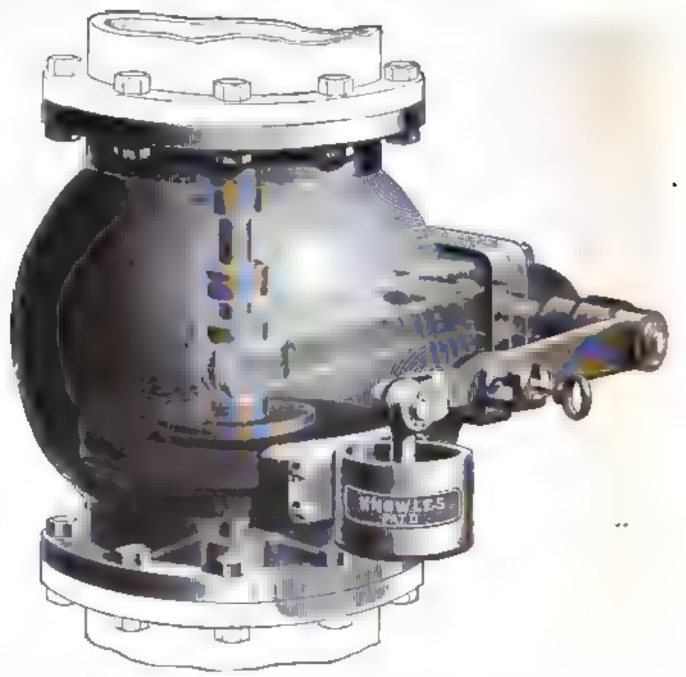
Mr. R. W. Bryan having resigned, the following appointments are made, in effect August 15, 1894: Mr. E. W. McKenna, General Superintendent Eastern District. Mr. J. D. Farrell, General Superintendent Western District.

E. L. Corthell announces that he has removed his offices to No. 71 Broadway, New York.

Manufactures.

THE KNOWLES AUTOMATIC EXHAUST RELIEF VALVE.

The valve shown by the accompanying engraving is one of the latest improvements applied to an engine and its condenser. It is intended to be placed in a branch leading from the main exhaust pipe to the atmosphere. The application of this valve is very necessary to an engine whose stoppage caused by failure of the vacuum in the condenser would meet with serious results. Sometimes through air leaks, accident to the air pump or the cessation of the injection water supply, the exhaust steam from the engine accumulates in the condenser and exhaust pipe, increasing the pressure and shortly stopping the engine. Also the hot steam passing into the air pump destroys the rubber valves and removes the load from the air pump, causing it to race and do serious damage. To prevent this and give the accumulated steam free admission to the atmosphere, the Knowles automatic exhaust relief valve was designed. The valve proper is practically a check valve composed of a material unaffected by steam heat and fitting perfectly air-tight on a brass seat contained within a cast iron spherical chamber. This valve remains seated and perfectly inactive as long as the engine is running with a vacuum, but as soon as this is lost, due to the above reasons, the pressure in the exhaust pipe immediately opens the relief valve, allowing the engine to run non-condensing. When the condensing apparatus is again in working order and the vacuum obtained,

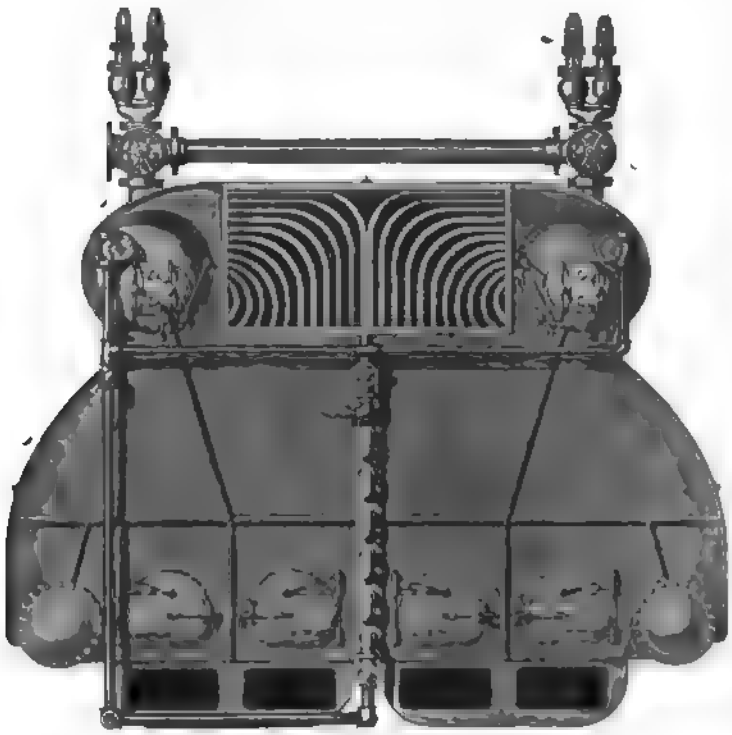


the valve closes automatically without shock or jar. At first thought it would seem as if an ordinary check valve would answer the same purpose, but this would soon hammer itself out of shape from the intermittent action of the engine's exhaust, and allow the air to enter and spoil the vacuum. To prevent this pounding and save wear and tear on the valve, a dash pot is provided, whose piston is connected by a double lever to the valve, and moving simultaneously with it. In the bottom of the dash pot cylinder is a small hole covered by a valve opening to the interior of the cylinder. As soon as the main valve rises the piston follows, allowing the air to enter the cylinder through the small valve. When the vacuum is again obtained, the atmospheric pressure forces the main valve back on its seat, thereby compressing the air in the dash pot, which, on account of the closure of the small valve, slowly escapes between the piston and cylinder, allowing the main valve to seat itself without shock or jar. This valve offers little or no obstruction to the exhaust steam in case the engine is to run non condensing, and can be held wide open for this purpose by an attachment shown on the engraving.

These valves are manufactured in various sizes to suit all requirements, and are for sale by the Knowles Steam Pump Works, 93 Liberty Street, New York.

MOSHER WATER-TUBE BOILER.

In the designing of a water-tube boiler for marine work it is necessary that it should be so arranged that it will occupy the least possible space and at the same time have its parts so related to each other that the expansion and contraction of the heated metals have the chance for a free movement. All of the generating parts should be of so small a diameter that in case any of them should be ruptured it will not necessarily involve a disaster. Circulation should be provided for so that not only the water will pass freely from the cooler to the more heated portions of the boiler, but that the steam should have an opportunity to liberate itself freely from the water. It is also very desirable that the passage of gases in going from the fire to the stack should move as nearly as possible at right angles to the heating surfaces. The feed water should not come in contact with the boiler plates, and ample facilities should be provided for cleaning the tubes and other parts. In addition to the above the boiler should show an economical efficiency in working condition



FRONT VIEW OF MOSHER'S WATER-TUBE MARINE BOILER.

The boiler which we illustrate in this connection is one that has been designed by Mr. C. D. Mosher, and has been applied to the fast yachts *Feiseen* and *Norwood*, which have a record of 31.06 miles and 30.5 miles respectively. They also have been used in more than half of the torpedo boats of the United States Navy.

Fig. 1 is a cross-sectional elevation of a boiler, showing the general construction; from this it will be seen that the boiler consists of two practically independent boilers, either one of which can be used separately and independently of the other. The brick wall which rises between the two grates carries a coil of pipe through which water is made to circulate. These pipes are connected at each end by return bends and absorb a large portion of the heat existing in the brick wall, thus greatly increasing the durability of the latter. The generating tubes start from the upper portion of the water drum and are open to form the sides and top of the furnace; they are then bent upward and outward to where they connect the upper portion of the water drum.

They extend the full length of the drums, and are bent so as to form a wall protecting the casing from the heat of the furnace; these tubes are spaced their own diameter apart, longitudinally, but in staggered rows, where they enter the steam and water drums. While in the circumferential rows they are spaced a somewhat greater distance apart. In this way the lower rows of tubes are so bent and interlocked with one another that they form a solid wall over and along the sides of the furnace, as shown in the sectional plan, fig. 3. The same thing is done with the outward tubes, forming a similar wall along and under the whole length of the boiler, as shown in fig. 3. The back portion of the inner row of tubes, however, is left staggered for the passage of gases, as is also shown in fig. 3. Fig. 2 is a longitudinal section of the boiler with the brick wall removed, showing the passage of gases. It will be seen that just forward of the center of the boiler there is a baffle plate extending down from the top, beneath which the gases must pass on their way to the stack; the object of this is to cause the gases to come more intermediately in contact with the tubes that are filled with solid water.

Circulation takes place down through the outward rows of tubes to the water drum and up through the generating tubes, where it is converted into steam and delivered above the water-line into the steam drum against a baffle plate under which the steam is caused to flow thence through the separators shown in fig. 1, where any entrained water is removed before entering the steam pipes.

The separator consists of a spiral tube, as shown in fig. 1, made of sheet metal, with the edges overlapping and forming a slot which opens downward. This tube extends nearly the full length of the steam drum, and contains a worm. One end is attached to the steam pipe, while the other is left open.

A perforated hood surrounds the upper portion of this tube, and the lower portion forms a trap extending only a short distance in length, while the upper portion extends somewhat beyond the enclosed tube, both ends of the hood being closed, one end allowing the tube to pass through it where it is attached to the steam pipe.

In action the steam or vapor enters the perforations, which extend the whole length of the top side of the hood, and passes back through the space between the hood and the tube, then enters the end of the slotted tube, where the steam is caused to take a rotary motion by the worm or auger-formed screw, the centrifugal motion thereby created causing the water to be thrown to the outside, where the overlapping lips of the tube catch any entrained water and deliver it to the trap below, where it overflows. It will be seen that this separator really consists of several separators contained in one, as each convolution of the worm, in combination with the overlapping edges of the tube, forms a separator of itself. A special feature of this separator, wherein it differs from all others, is that, after

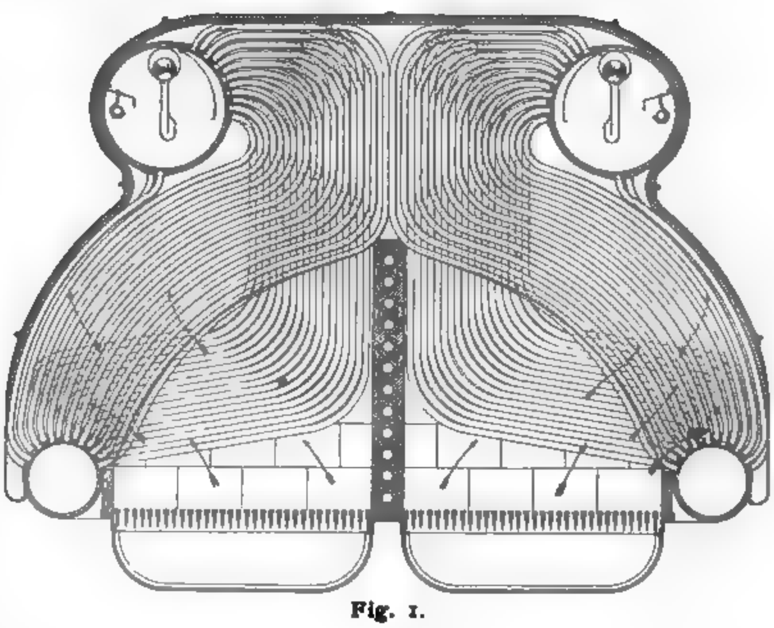


Fig. 1.

TRANSVERSE SECTION.

the separation has once taken place, the water of separation does not again come in contact with the currents of steam.

One advantage claimed for this boiler is the independence of the two halves, so that, should one half be injured by a shot, the other, by continuing to work, gives the vessel an opportunity to escape. The center of gravity is very low, which is a feature which will be appreciated in marine boilers.

In some tests made with these boilers on an 8-hour run, where there was 1,100 sq. ft. of heating surface, with a grate area of 33 sq. ft., 235 lbs. of coal were burned per hour, or 7.1 lbs. per square foot of grate. The water evaporated at 185 lbs. pressure from 78° F. was at the rate of 2,143 lbs. per hour.

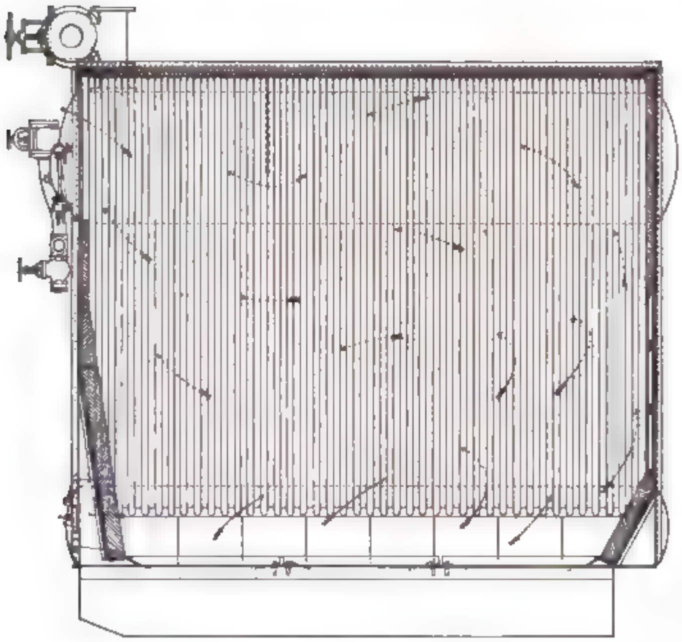


Fig. 2.

LONGITUDINAL SECTION (FIRE-BRICK WALL REMOVED).

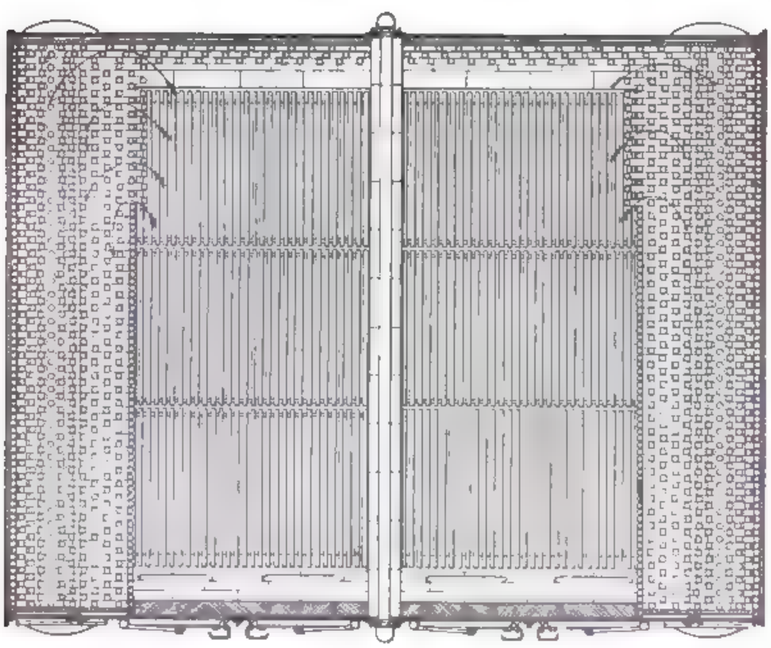


Fig. 3.

SECTIONAL PLAN

The temperature in the stack was 443° F. and the water evaporated per pound of coal was 912 lbs.; reducing this to water evaporated per pound of coal and at 212°, we have 10.92 lbs. per pound of coal, or 11.07 lbs. per pound of combustible. This figures out that the useful effect or efficiency of evaporated water is 76 per cent.

Boilers of this type are now being built for several vessels, one of which is guaranteed to be a record breaker, and is being constructed by the builders of the *Yankee Doodle*.

THE THURMAN FUEL OIL BURNER.

OUR engraving herewith (fig. 1) represents this burner, and the sketch (fig. 2) shows its application to a boiler, forges and a glass furnace. The operation of the burner is as follows: The oil is stored in an underground tank, *D*, shown by dotted lines in fig. 2. Compressed air is carried to this tank through the pipe *B*, which forces the oil up through the pipe *C* to the burners *F F F*. Oil is admitted to the burner, shown in fig. 1 by a pipe, *M*, and steam or compressed air by the pipe *N*. The stream of oil and stream of air mingle in the burner, and the oil is thus thoroughly "atomized." A stream of hot

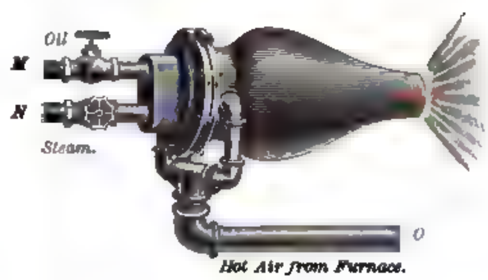


Fig. 1.

air is also conducted to the burner by the pipe *O*. This hot air is intimately mingled with the atomized oil, and escapes from the mouth of the burner into the furnace, and then contains within itself all the elements of combustion, and when lighted, perfect combustion results, and continues uninterruptedly so long as the mingled stream of atomized oil and air is delivered into the furnace.

In fig. 2 *A* is the air compressor. Through pipe *B* the compressed air presses on the surface of the oil in tank *D*, forcing the oil through the pipe *C* direct to the burners *F F F*, where it is met by the pressure of air from the same source of power. *N N N N* is the hot-air pipe from furnace. The proportions of oil are regulated by the burner valves *K K K K*, and proportions of air are regulated by the valves *J J J J*. The burner under the boiler *M* can be operated by either air or steam. *L* is the steam valve, *P* is the inlet to tank and *R* is the vent. The air pressure thoroughly atomizes the oil, and the oil atoms and air atoms intimately commingle with the hot-air atoms from the furnace, and pass from the mouth of the burner in a highly combustible and vaporous form with perfect combustion. In this system steam can be substituted to atomize the oil instead of air by substituting an oil pump and stand pipe instead of the air compressor and receiver.

This system of burning crude oil is adapted to all classes of work, such as boilers, reverberatory furnaces of all kinds. Copper and brass, it is said, are melted in crucibles at one-half the cost of coal, and the crucibles are more permanent. Puddling, forges, dryers of all descriptions. Glass making and working are successfully accomplished with large savings in fuel. Burning brick, tile and pottery of all kinds. The burners generate pure hydro-carbon gas, and wherever used every unit of heat the oil contains is utilized and applied without any expensive intermediate process of treatment.

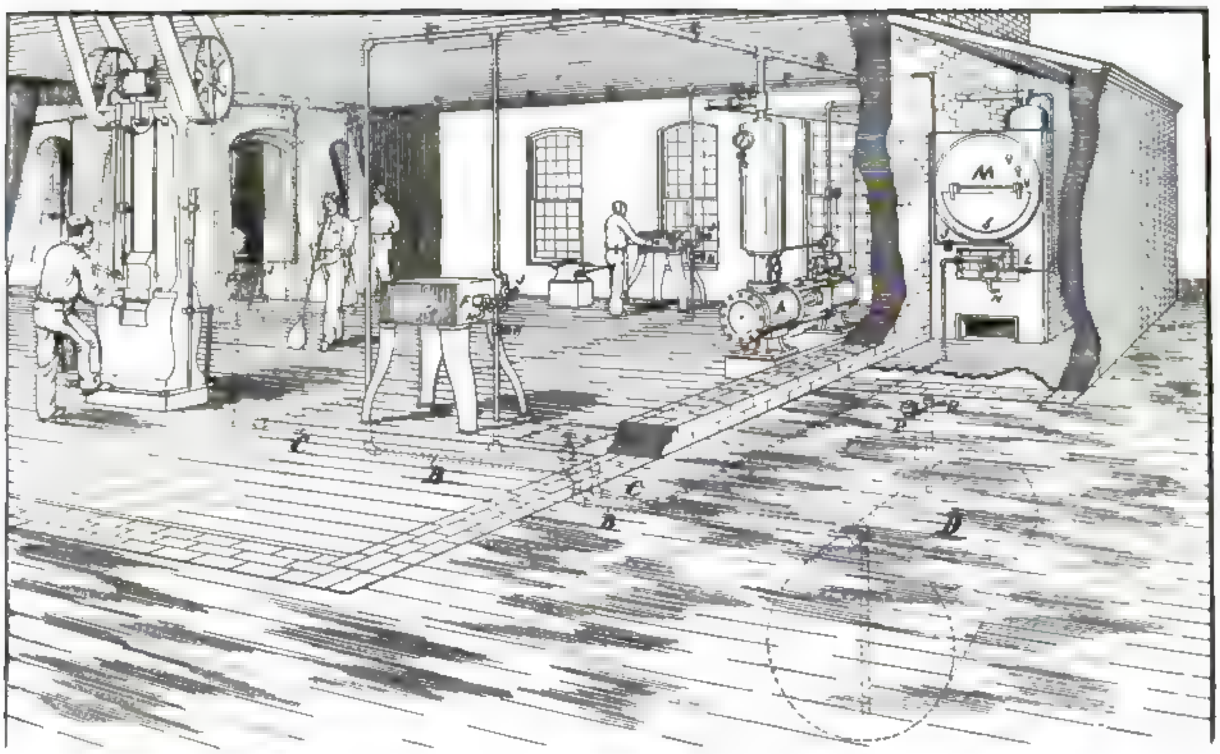
The numerous advantages of oil over coal for fuel will readily be appreciated from the following facts: It diminishes the expense of handling coal. It costs at least 5 cents per ton to unload it, providing you have a switch to your bins, before it is distributed about the plant. There is a shrinkage of 5 per cent. in weight, and about the same in waste by

handling. It is an impossibility to burn and not consume a certain amount of coal from which no benefit is derived, caused by the necessity of opening the doors, and cold air rushes in, causing an immediate and reverse change to take place, while with oil, if your fires are too hot, turn a valve, save your fuel.

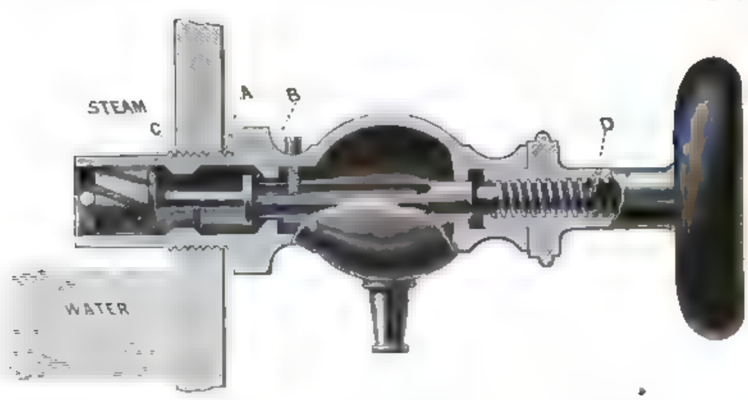
The labor of feeding the fires, clinkering the boxes, taking care of ashes and the wear on boilers, kilns are not needed in the use of oil.

One car of oil is said to be equal to three cars of coal, and by attaching a rubber hose or gas-pipe, in 2 hours you have obtained the results of the labor of one man for 1½ days, and only consumed about 10 minutes in preparing for the operation of unloading, which afterward needs no attention. By the aid of a pump your fuel is distributed and always ready for use.

The Thurman Fuel Oil Burner Company, of Indianapolis, Ind., are designers, contractors and engineers for complete fuel oil equipment.



SHOP EQUIPPED WITH THURMAN'S FUEL-OIL BURNERS.



ASHLEY'S AUTOMATIC GAUGE-COCK.

ASHLEY'S SAFETY AUTOMATIC GAUGE-COCK.

This gauge-cock is especially adapted to locomotive and portable boilers, as will appear from the description. It screws into the boiler or water column, as shown in the engraving. The sectional view shows two valves, and two valve seats in the cock, one behind the other, and one of which is cast in one piece with the central stem as shown, having a pin projecting from its center, designed to strike against the face of the second valve.

The operation is as follows: Steam being on the boiler, the pressure would force both valves to their seats as shown. To open the valve, turn the handle—which is attached to the sleeve outside of the screw—from right to left, which will unscrew on the central stem; then by pushing the handle in toward the boiler, the central stem would slide inward, forcing the first valve from its seat a short distance, when the pin attached to the back of the first valve would strike the face of the second valve and force it from its seat. The steam would then flow through the spiral wings of the second valve and through the first valve into the atmosphere, in its passing causing the second valve to rapidly revolve by its action on the spiral wings or flanges, thus cutting loose all scale or sediment which may have lodged in the valve chamber; the steam blowing through would carry the sediment with it and cleanse the valve. If the engineer lets go of the handle, the pressure of steam would instantly force the valves to their seats; but as the second or flanged valve comes to its seat a little before the first valve, and as it is being rapidly rotated by the action of the steam on its flanges, it strikes the seat while revolving and regrinds the valve seat slightly each time the valves are closed. The next feature is the arrangement of the second valve and its seat. Suppose the gauge-cock should be broken off of the boiler in a collision or by a blow, it would of course break just outside of the boiler sheet, the weakest part, which would leave the second valve, which is within the boiler, closed, and consequently the engineer would not be scalded; and if it should happen when his engine was running, he would not have to stop his engine, as he would otherwise be forced to do. The screw 2 fits into the groove of the central stem and keeps the stem from revolving. After the valves have automatically closed by the pressure of steam, the engineer can screw up the handle which would draw the first valve to its seat, and it could not be accidentally forced open by being pressed against. Manufactured and for sale by Frank M. Ashley, M.E., 136 Liberty Street, New York City

NOTES.

A Correction.—Owing to a typographical error, the price of oil tallow and waste for the Flint & Père Marquette Railroad was placed at 1.63 cents per mile in our locomotive returns for April. It should have been 0.163 cent. This includes illuminating and lubricating oils and waste.

The "New York."—Since a recent examination of the cruiser *New York* has been made it has been decided that the midship ammunition-room is too near the boilers, and it is probable that this room will hereafter be used as a coal bunker in accordance with the recommendation made by the Board of Inspection.

Six-Camera Telescope.—A new instrument in the form of a photographic telescope with six cameras has recently been completed for the Yale Observatory. By means of it, it would be possible to take six simultaneous photographs; one of the applications being to take simultaneous photographs of meteors by closing electrical circuits at different points where single telescopes are erected.

The East River Tunnel. — The tunnel under the East River from East Seventy-first Street, in New York, to Ravenswood, a section of Long Island City, has just been completed. It was built for the East River Gas Company. The tunnel is arched with heavy steel plates in all places where it was not excavated through solid rock. It will be concreted to make a perfect floor for the company's purposes. From the generators at Ravenswood three immense mains, one 48 in. in diameter and two 36 in. each, will carry gas to New York, where it will enter the service pipes of the company and be distributed throughout the city. The level of the tunnel is 135 ft. below the surface at the New York end and 147 ft. at Ravenswood. In length it is 2,541.4 ft.; in width, 10 ft., and in height, 8½ ft. in the center of the arch. There were about 216,000 cub. ft. of earth and rock removed from the excavation.

The "Minneapolis."—The Trial Board have made their report to the Secretary of the Navy regarding the recent trial trip of the *Minneapolis* reported in our last issue. According to the report, the least water of the 44-knot course was 30 fathoms. There are a few little deficiencies incident to an incomplete ship, such as pumps, cellulose fillings, etc. On starting on her trial trip the displacement was 7,475 tons. The speed attained after making tidal corrections was 23.53 knots per hour; the report states that the performance of the machinery was highly satisfactory, that the engines ran smoothly, and that there was no tendency to heating except the high-pressure cross-head bearings of the intermediate cylinder of the port engine; boilers worked under forced draft and showed no evidence of priming. The collective indicated H.P. of the main engines during the trial run was 20,366; that of all the machinery in use, 20,812. It seems that, owing to a lack of power or a great reduction of steam by the reducing valve, the requirement that the helm be put hard over from port to starboard cannot be done in the time required. The Board recommended that hereafter vessels are not to have their speed trial until completely fitted in all respects excepting the armament fittings and paint inside and out.

Standard Brake Company.—This company has been perfecting a new triple valve for air brakes that does not infringe on any other patents and that is perfectly interchangeable with those now in use. It has also these valuable improvements: 1. It will release the brakes on long trains with certainty. 2. The auxiliary reservoirs can be recharged while the brakes are still applied as well as while they are off. 3. By the addition of one part to the above-mentioned triple valve (which we have named the "accelerator") we are enabled to apply the brakes much more quickly than is done at present. While the "accelerator" forms a part of the triple valve, it is also manufactured separately, so that it can be attached to other compressed air-brake systems. This company has sent us indicator diagrams showing that with their accelerator the brakes are applied very much more quickly than they are with the ordinary triple valve. Mr. Dudley, in his report to the New York Central & Hudson River Railroad Company on the air-brake tests made by him two years ago, states that it is more difficult now to decrease the time of application of the brakes on a 50-car train by $\frac{1}{10}$ second than it was some years ago to decrease it from 10 seconds to 3½, as Mr. Westinghouse did when he invented his "quick-action" device.

University of California.—This free university was incorporated by the Legislature of California in 1868. The United States gave the State land valued at $2,500,000, of which over $2,000,000 in value have been sold and invested, the interest upon which is annually applied toward the expenses of this university, which has colleges of letters (classical and literary courses), agriculture, mechanics, mining, civil engineering and chemistry, all located at Berkeley. The colleges of law, dentistry, medicine and pharmacy, and the Mark Hopkins Art Institute are located in San Francisco, and the Lick Astronomical Department is located at Mount Hamilton.

The location at Berkeley is unsurpassed, and the buildings and grounds first-class and ample. The library and Bacon Art Hall are gems of literature and art. One hundred and thirty-five professors with 1,400 students of both sexes are all doing good work in giving and obtaining the benefits of a liberal education to the coming bright men and women of this progressive age, while the classical and literary departments are well provided for. The engineering, mechanical, electrical and chemical departments, which number 35 per cent. of the students, have recently been enlarged and endowed in one instance by $400,000 in one bequest, so that, with the exception of Chicago and Cornell, no free university in America surpasses this. Its long list of able professors, from President Martin Kellogg down, are an honor to any university, and each succeeding year will make it more honorable to have graduated at this institution.

Ruskin on Locomotives.—The locomotive has been the incentive for a good deal of extraordinary eloquence, but it is thought that it will be difficult to find anything equal to the following quotation from a volume of recently published lectures by Ruskin:

"I cannot express the amazed awe, the crushed humility, with which I sometimes watch a locomotive take its breath at a railway station, and think what work there is in its bars and wheels, and what manner of men they must be who dig brown ironstone out of the ground and forge it into THAT! What assemblage of accurate and mighty faculties in them; more than fleshly power over melting crag and coiling fire, fettered and finessed at last into the precision of watch-making; Titanian hammer-strokes, beating out of lava these glittering cylinders, and timely respondent valves, and fine-ribbed rods, which touch each other as a serpent writhes in noiseless gliding, and omnipotence of grasp; infinitely complex anatomy of active steel, compared with which the skeleton of a living creature would seem, to a careless observer, clumsy and vile—a mere morbid secretion and phosphatous prop of flesh. What would the men who thought out this, who beat it out, who touched it into its polished calm of power, who set it to its appointed task and triumphantly saw it fulfill this task to the utmost of their will, feel or think about this weak hand of mine, timidly leading a little strain of water-color which I cannot manage, into an imperfect shadow of something else—mere failure in every motion, and endless disappointment? What, I repeat, would these iron-dominant genii think of me, and what ought I to think of them?"

Chinese Railroad Employés.—The correspondent from China writes to an exchange that if the Government at Peking should decide to build roads all over China there would be no trouble in their construction, and the wages and labor are such that they could be laid and equipped more cheaply here than in any other part of the world. Ordinary coolie labor costs about 8 American cents a day, and the farm wages in this part of China are about 4 of our cents for 10 hours' work. The brakemen on the trains get 6 silver dollars, or not much more than 3 American dollars, a month as wages; firemen receive from $5 to $10 in silver, and engineers get from 8 to 30 American dollars a month. The best engineers and the best workmen come from the south of China, and these receive the highest wages. The Cantonese engineers start in at 30 silver dollars, and they can rise in 9 years, if they are good workmen, as high as $60 a month, but they cannot make more than this. Northern men begin at $15 and can rise to $35 a month. These wages are for 60 hours a week, anything over that being paid for at the rate of 15 cents an hour. Conductors receive less than the engineers, and certain classes of workmen get two Sundays off in each month as holidays. In ordinary labor there are no holidays in China, and the contractor expects his hands to work Sunday and every day, except a week or so at the Chinese new year. In the works here there are a great number of blacksmiths, carpenters and miners employed. The northern carpenters get from 5 to 8 silver dollars, and Canton carpenters receive from $20 to $30 a month. Blacksmiths get all the way from 5 to 40 silver dollars a month, and the wages of miners are 18 cents a day. At such wages skilled men can be gotten by the thousands in any part of China, and the building of railroads is merely a matter of decision on the

part of the Government that they shall be built, and of the little time and comparatively little money required to make them.

The French Battleship "Le Carnot."—The great French battleship, which was laid down at the Arsenal of Le Mourillon, Toulon, in July, 1891, as the *Lazare Carnot*, but which henceforth, in memory of the assassinated President as well as of his grandfather, is to be called *Le Carnot*, was launched on Thursday, July 12. She is practically a sister ship to the *Charles Martel*, which was launched at Brest on August 28, 1893. The length of the vessel is 396 ft., her beam 71 ft., her draft aft 27½ ft., and her displacement 11,882 tons. She has a complete steel belt with a *maximum* thickness of 17.7 in., and a curved steel deck 2.75 in. thick. Above the water-line belt there rises for an additional height of 4 ft. a steel belt of 4-in. armor. The machinery of the ship consists of a pair of compound vertical engines with three cylinders, fed by 24 Lagrafelle and D'Allest boilers. At 95 revolutions, with forced draft, 13,500 H.P. should be developed, giving a speed of 18 knots, and with 85 revolutions, with natural draft, 9,500 H.P., giving a speed of about 17 knots. The machinery weighs 1,178 tons. The normal coal capacity is 800 tons, or enough for 4,000 knots' steaming, but when all subsidiary bunkers are full, coal for 5,000 knots can be carried. The cost of *Le Carnot* will be, for the ship, £960,000; for her gun and torpedo armament, £104,000; and for machinery and boilers, £127,200, or, in all, £1,191,200. The armament will consist of two 11.8-in guns, one in a 14.6-in. turret forward and the other in a similar turret aft, the forward gun being 26 ft. and the after gun 19.5 ft. above the water line; two 10.6-in. guns, one in a 14 6-in. turret on each beam, eight 5.5-in. quick-firing guns, mounted singly in 3.9-in. turrets, four on each beam; four 2.5-in. quick-firing; twelve 1.8-in. quick-firing, and eight 1.45-in. quick-firing or Maxim automatic guns. There will also be four above-water and two submerged torpedo-launching tubes. The most significant feature of the vessel is the enormous power of her right ahead and right astern fire. In each case this is furnished by one 11.8-in., two 10.6 in. and four 5.5-in., besides smaller guns. Beam fire is furnished by two 11.8-in., one 10.6 in and four 5.5-in. guns, so that in every direction the ship is offensively strong to an exceptional degree. In this respect we have nothing that can compare with her.

Recent Patents.

WIGHTMAN'S STARTING APPLIANCE FOR COMPOUND ENGINES.

"The object of my invention is to provide simple and effective means for positively actuating the converting valve mechanism of a compound machine, either by fluid pressure or by manually applied power as desired, in order to enable the engineer to operate the engine as a simple or non-compound engine, whenever and during such periods—of any desired length—it may become necessary, or be deemed advisable, to so operate it, as when starting a train or ascending a long and heavy grade, and to immediately reinstate it in normal operation as a compound engine when the conditions are such as to make compound operation proper or desirable.

"This invention consists in the combination of a fluid pressure cylinder, a piston working therein, a valve operating rod connected to said piston and to a converting valve mechanism, a distribution valve controlling the action of motive fluid upon said piston, a stem connected to said distribution valve and connections for positively actuating said stem by the reversing gear of a compound engine.

"My invention is more particularly designed for application in two cylinder compound locomotive engines, in which provision has heretofore been made for the direct admission of boiler steam to, and the independent exhaust of steam from, both cylinders of the engine in the manner of a simple or non-compound engine, when a temporary increase of power is required, as in a starting train. The converting valve mechanisms employed for this purpose, which are of various constructions, are adapted, in many instances, to be automatically operated by variations of pressure, and in others to be operated by hand through connections to a lever moved by the engineer. Inasmuch as it is desirable to avoid as far as possible the use of levers additional to those required in the normal operation of the engine as compound, starting valves have been actuated through connections to the ordinary reverse lever, as in the so-called Linder system and others; but it will be obvious that in such cases the friction and unbalanced pressure, if any, which resist the movement of the valve or valves actuated by the engineer, impose additional labor upon him in moving the reverse lever.

"Under my invention the converting valve mechanism is normally and ordinarily actuated by fluid pressure, which is applied by the engineer, preferably in and by the movement of the reverse lever, and the only additional manual power exerted by him is that required to effect a short traverse of a small distribution valve which is so slight as not to be appreciable. In the event of damage or derangement of any of the fluid pressure members of the appliance, the mere detachment of the bolt connecting the piston thereof with the rod which operates the converting valve mechanism, enables the latter to be operated by hand whenever desired.

"In the accompanying drawings, fig. 1 is a diagrammatic side view of a compound locomotive engine, illustrating an application of my invention; fig. 2, a side view in elevation, showing the fluid pressure cylinder, the reverse lever, and the intermediate connections from the reverse lever to the distribution valve; fig. 3, a view, partly in elevation and partly in section, and on an enlarged scale, of the fluid pressure cylinder, the distribution valve and its chest.

"In the practice of my invention, as applied in connection with a two-cylinder compound locomotive engine of the general type now employed in American railroad service, I provide a fluid pressure cylinder, 1, which may be, as shown, located within the cab 2 and secured to the side of the fire-box 5. The cylinder 1 is provided with a properly packed piston, 6, secured upon a rod, 7, which passes through a stuffing-box, 8, in one end of the cylinder. A valve-chest, 9, is formed upon or secured to the cylinder 1, and communicates therewith near each of its ends by induction and eduction passages 10 and 12 leading respectively to supply ports 13 and 14 in a valve face, 15, within the valve chest 9. A supply pipe, 16, leads into the valve chest above the valve face 15 from any suitable source of fluid pressure supply, being, in the instance shown, a chest, 17, communicating by a pipe, 18, with the dome 19 of the boiler, and an exhaust pipe, 20, leads from an exhaust port, 21, located in the valve face between the supply ports 13 and 14 to any convenient point of discharge, as, for example, the ash-pan, 22. It will, however, be obvious that in engines which are provided with an air-brake equipment, as is now generally the case, the supply pipe 16 may be readily connected with the main air reservoir or other suitable member of the air-brake apparatus, so as to admit of the employment of compressed air for the actuation of the piston 6 in lieu of steam, as in the specific construction shown; and such connection, which is preferable when facilities therefor are available, I include in my invention as the mechanical equivalent of that shown.

"The piston-rod 7 is connected by a detachable pin or bolt, 23, to a yoke, 29, and by rods 24ª to a valve operating rod 24, which extends toward the smoke-box 4 of the engine, and is coupled by suitable intermediate connections, in this instance a double armed lever, 25, and a link, 26, to the stem 11 of a converting valve mechanism of any suitable and approved construction, which is fitted to reciprocate in a chest in one of the saddle sections 3 on which the smoke-box 4 is supported and to which the cylinders of the engine are connected. The lever 25 is journaled on or by a pin, 27, and the relative lengths of its arms are such as may be proper to impart the desired range of reciprocating movement to the stem 11 and the converting valve mechanism connected thereto.

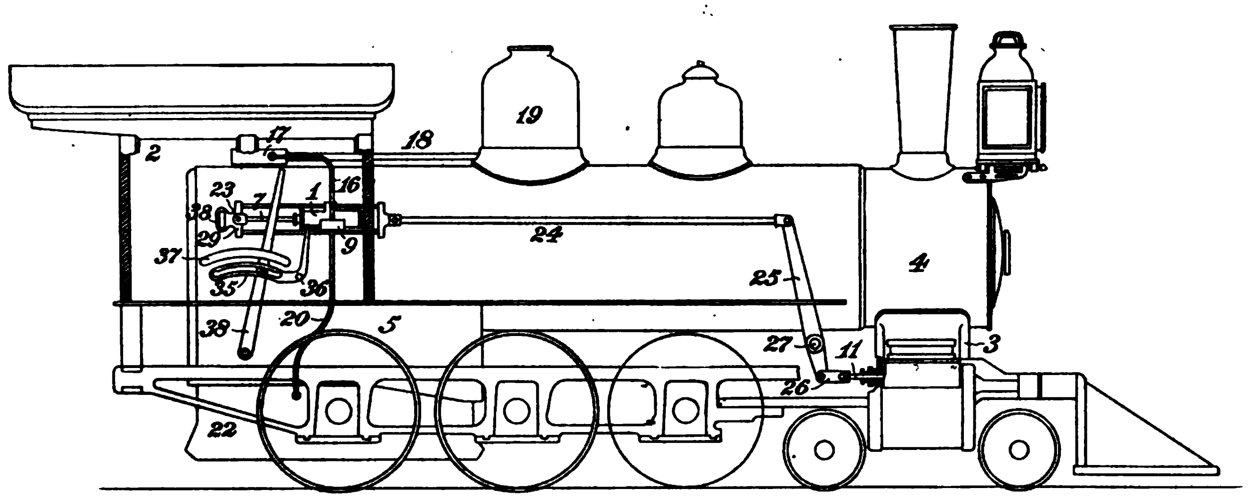
"Inasmuch as any suitable and preferred mechanism may be employed, and as the same does not in and of itself constitute part of my present invention, it will not be herein at length described.

"In order to insure the rectilineal movement of the valve operating-rod 24, said rod is, adjacent to the fluid pressure cylinder 1, bifurcated or fixed to two parallel guide rods 24ª, which pass through guides 28 on the cylinder 1, and are connected at their rear ends by a block, 29, which receives the connecting-pin or bolt 23 of the piston rod 7, and is provided with a handle, 38. In the event of the derangement or breakage of any member of the fluid pressure apparatus, or of the failure of supply thereto, the connecting-pin 23 may be detached and the rod 24 and connected converting valve mechanism be operated by the engineer by the application of manual power to the handle 38.

"The supply and exhaust of motive fluid to and from each end of the cylinder 1 are effected and controlled by a distribution valve, 30, which is preferably, as shown, of the short D slide type, and is fitted to be reciprocated on the valve face 15 of the chest 9. The stem 31 of the distribution valve passes through a packed stuffing-box, 32, in one end of the chest, and is normally actuated, through intermediate connections, by the reversing gear of the engine, said connections being so organ-

ized that when the reverse lever is moved to or near its full forward or its full backward position, the distribution valve 30 will be, in either case, and in and by such movement of the reverse lever, moved into the position shown in fig. 5, thereby admitting motive fluid on the rear side of the piston 6 and exhausting it from the front side thereof, while, in and by the movement of the reverse lever to any intermediate position, the distribution valve will be moved backward so as to uncover

FIG. 1.

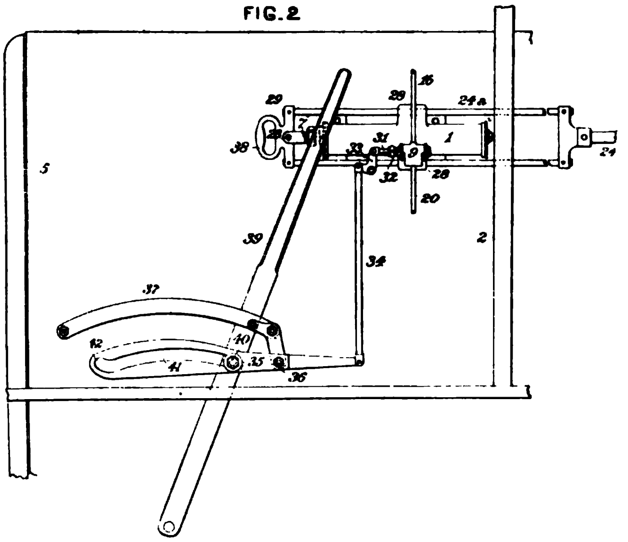


WIGHTMAN'S STARTING APPLIANCE FOR COMPOUND LOCOMOTIVES.

the forward supply port 13 and place the rear supply port 14 in communication with the exhaust port 21 through the exhaust recess of the valve, thereby admitting motive fluid on the front side of the piston 7 and exhausting it from the rear side thereof. The piston 7 will correspondingly be forced to and remain at the front or the rear end of the cylinder 1, and the converting valve mechanism be moved into position for the operation of the engine as a simple or as a compound engine, as the case may be.

"In the instance exemplified, the stem 31 of the distribution valve 30 is shown as coupled, either directly (as in fig. 1) or

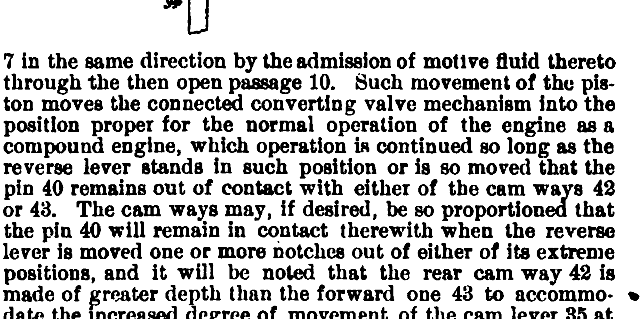
FIG. 2



intermediately, through a bell crank lever, 33, and link 34, as in figs. 2 and 3, to one end of a cam device consisting of a double-armed cam lever, 35, which is journaled on a pin, 36, below and adjacent to the segment 37 of the reverse lever 39. A curved slot, 41, is formed in the arm of the cam lever 35 opposite to that which is coupled to the distribution valve stem, said slot being located below and eccentric to the segment 37 of the reverse lever, and having upwardly curved cam ways 42 and 43 at its ends. A pin or bolt, 40, fixed to the reverse lever 39, traverses in the slot 41 and moves the cam lever 35 about its pivot 36 by its engagement with and disengagement from the cam ways 42 and 43, as the reverse lever 39 is moved into or out of either its extreme forward or its extreme backward position.

"The entrance of the pin 40 into either of the cam ways 42 or 43 depresses the arm of the cam lever 35 in which said cam ways and the intermediate slot 41 are formed, and elevates the opposite arm, thereby moving the distribution valve 30 to the right, and effecting the movement of the piston 6 in the same direction by the admission of motive fluid thereto through the then open passage 12. Such movement of the piston moves the connected converting valve mechanism into the position proper for the operation of the engine as a simple or non-compound engine, which operation is continued so long as the reverse lever remains at or closely adjacent to either extremity of its arc of traverse. By the movement of the reverse lever, in either direction toward the middle of its arc of traverse, for the purpose of cutting off steam at a desired point in the stroke of the pistons, as is practiced ordinarily after the train has been started, the pin 40 is moved into the portion of the slot 41 between the cam ways 42 and 43, elevating the arm of the cam lever 35 in which said slot and cam ways are formed and depressing the opposite arm, thereby moving the distribution value 30 to the left, and effecting the movement of the piston

FIG. 3.



7 in the same direction by the admission of motive fluid thereto through the then open passage 10. Such movement of the piston moves the connected converting valve mechanism into the position proper for the normal operation of the engine as a compound engine, which operation is continued so long as the reverse lever stands in such position or is so moved that the pin 40 remains out of contact with either of the cam ways 42 or 43. The cam ways may, if desired, be so proportioned that the pin 40 will remain in contact therewith when the reverse lever is moved one or more notches out of either of its extreme positions, and it will be noted that the rear cam way 42 is made of greater depth than the forward one 43 to accommodate the increased degree of movement of the cam lever 35 at and near its rear end, due to the greater distance thereof from the pivot 36 of the lever."

The above device is the invention of Mr. Daniel A. Wightman, of the Pittsburgh Locomotive Works. His patent is dated July 3, 1894, and is numbered 522,544.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

Formerly the RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

The American Railroad Journal, founded in 1832, was consolidated with Van Nostrand's Engineering Magazine, 1887, *forming the Railroad and Engineering Journal, the name of which was changed to the American Engineer and Railroad Journal, January,* 1893.

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NEW YORK, OCTOBER, 1894.

ANNOUNCEMENT.

AMONG the many "congresses" which were held last summer in Chicago was an International Conference on Aerial Navigation, which proved to be successful and interesting beyond expectation. In order to make the Proceedings of that Conference accessible to readers who were interested in the subject, the AMERICAN ENGINEER issued a monthly supplementary publication called AERONAUTICS. As these Proceedings have all been printed, and, owing to insufficient support, that journal has been discontinued, and as many of its subscribers and others have manifested a great deal of interest in the paper, and have expressed a desire that some publication of that kind should be continued, and as the science and art of Aerostation is attracting more attention from intelligent people, Aeronautics will hereafter be made a supplementary subject in the AMERICAN ENGINEER. Under that heading it is intended to give the most recent reliable information, relating to the science or art of Aerostation, which indicates any real advance in that direction, or any increase in our knowledge of either the theory or the art of navigating the air. As special space will be devoted to that subject, those readers who are not interested in it can exercise the inestimable privilege of skipping it, and of vituperating those who are as lunatics and "cranks."

To those engaged in the investigation of the principles or practice of Aerostation an invitation is extended to send us data and reports of the results of their researches and experiments, or drawings, photographs, or other illustrations of interesting apparatus. The subjects concerning which we desire contributions do not include mere speculative schemes or mathematical calculations; and it is intended especially to emphasize the fact that the publisher of this paper is not in any sense a "promoter" of such or any other projects excepting his own, and that he has no facilities nor aptitude for raising money for purposes of that kind, and has never acquired the peculiar faculty by the exercise of which the confidence of capitalists is secured.

The paper is his sole and exclusive property, and it is not the organ nor under the influence or control of any association or interest whatsoever, and will represent only the views and opinions of its owner and editor; and the injunction of a distinguished journalist "never to print a paid advertisement as news matter" will be scrupulously observed.

The co-operation of its subscribers and readers is solicited, to extend the circulation of the paper, during the coming year, into wider fields of influence and usefulness. They can aid materially by sending in either new subscribers or the names and addresses of persons likely to be interested in a journal such as it is hoped and intended the AMERICAN ENGINEER will hereafter be.

M. N. FORNEY, 47 Cedar Street, New York.

EDITORIAL NOTES.

IN another column we reprint a letter written to a contemporary regarding the electrical distribution of power. It presents a fair summary of the advantages of the new method of transmission of power over the old; but the writer allows himself to be carried away by his enthusiasm when he states that 80 per cent. of the power developed by the engine "is usefully employed by the machines." This percentage is so far above anything ever obtained in practice, that the statement would deceive no one. The article stands, therefore, as an argument in favor of electrical transmission from the general facts of the case rather than from particular details of the work done.

LOCOMOTIVE engineers are frequently called upon to act quickly or not at all; their work is of a kind that tends to develop coolness, presence of mind, nerve, or whatever else you may choose to call that which enables a man to do the proper thing in the face of an impending calamity; but the quality displayed by some of the engineers in the Northwest during the recent forest fires is of a higher order of bravery—that is, heroism of the first rank. No one who has not faced one of those terrific fires in the pines can imagine the heat and terror of it; and to deliberately take a train of cars into such a place to rescue people imprisoned by the flames is a deed that deserves praise beyond the power of words to convey.

IT appears, from the recent comments of English papers, that the British Admiralty is experiencing some trouble in securing the services of competent men for the engineer's department in their vessels. The trouble lies in the ranking of the line and engineer officers. The latter object to the position which they are obliged to occupy; and men thoroughly qualified to fill the positions will not accept them. It is the same trouble that our own department is experiencing, and against which Commodore Melville has so often protested. The engines of a modern battleship are no longer auxiliary attachments, but the very life of the vessel; and it cannot be long before the men in charge of them will be recognized as entitled to a rank equal to that of officers of the line.

RAILWAY officials who are overwhelmed with applications to "try a new coupler" often wonder why so many men who know nothing about railroading should be applicants for patents on car couplers. The explanation is comparatively simple. For years there have appeared in the daily press paragraphs like the following, recently published in a Pittsburgh paper: "There is a fortune in sight for the genius who

invents a safety car coupler. Patents are issued every day for such devices, but they are anything but safe in practical use." The article then goes on to enumerate the terrible loss of life and limb from coupling cars, leaving the impression that if only a safe and sure automatic coupler could be invented, this holocaust would be stopped; and straightway the butcher, the baker, and the candlestick-maker proceed to invent a coupler that will be a boon to humanity and incidentally a fortune unto themselves. Some time ago the Patent Office issued a circular letter in which it was announced that no patent would be granted upon a flying machine until it had been practically demonstrated that the said machine would fly. It may be impossible, but it seems that it would be a good idea to call a halt on car couplers. They have been issued at the rate of a trifle over one each day for several years, and, to judge from the conversation of the majority of railroaders, we have about enough.

THE PROCEEDINGS OF THE MASTER MECHANICS' ASSOCIATION.

II.

Last month we commenced a general review of the Report of the Annual Convention of this Association, which had then just been issued by the Secretary in book form with commendable promptness. Resuming this review, which was left off at the point where the discussion of compound locomotives was commenced. This discussion was a sequence to a resolution that the convention resolve itself into "a compound experience meeting" at noon—the hour set apart for topical discussions—on the first day's session. The remarkable feature brought out by this discussion was the great difference of opinion which it revealed with reference to the compound system. A few quotations will show this difference. Mr. Garstang, for example, said of a locomotive built by the Richmond Locomotive Works, and which had been in use on his road since last December, and ran "first in and first out," that it did not require any special engineer to handle it and that there had not been "an outlay of one cent on the mechanism connected with the compound feature."

Mr. Vauclain, who, in connection with the Baldwin Locomotive Works, has had, probably, more experience in the construction of compound locomotives than any other person, said that they "had no reason whatever to change their minds in regard to the adaptability of compound locomotives to all classes of service."

Mr. Lauder—whose death since then we and many of our readers have had occasion so recently to lament—agreed with what Mr. Vauclain had said, in thinking that "the compound locomotive will do as great a variety of work as the simple engine. On suburban business, when the trains range from seven to ten cars, and have nine stops in 11 miles, the compound engine (Dean's) he thought would 'get away with' any simple engine they had in the service," and he added that he "did not know of any kind of service that the compound locomotive is not well adapted to. . . . The extra cost of maintenance will be something, no matter what interested parties may say; whether we will get enough out of our saving in coal to pay for these extras in the way of other expenses is still to be determined. . . . I think it is perfectly safe to say that we are going to have a compound locomotive in which we can safely count on a saving of 20 per cent. over the best simple engine that can be built. I am satisfied that we are going to get—we have not got it yet—an engine that will give us a saving of about 20 per cent. *But to get that saving the compound locomotives must be kept in better condition than we have been in the habit of keeping our simple engines.*"

Mr. W. S. Morris, of the Chesapeake & Ohio Railroad, said of an engine built by the Richmond Locomotive Works, and which has been operated on his road, that "it had no increased steam pressure over 10 ordinary simple engines. The mileage for the year 1893 made by the compound was 14 per cent. greater than the average mileage of the 10 simple engines. The total cost of repairs was 80 per cent. of the total cost of the average of the 10 simple engines. The oil and waste consumed was 92 per cent. of the average of the 10 simple engines. The fuel consumed was 84 per cent. of the average of the 10 simple engines. The total expenses of the engine, including everything, was 94 per cent. of the total of the 10 simple engines, and the cost per mile run, in cents, was 83 per cent. of the average of the 10 simple engines. The days in the shop during the year were five as against 10 for the average of the other 10 engines. The engineer states that he did not have any difficulty whatever in running the engine in any service that it has been placed in. That will refer to general freight service, local and through. The firemen all seem to have a special liking for the machine, and their reason is that it burns less coal, which is a very practical reason for concluding that the engine is saving in that direction. The shop expenses, I will say, although the average for the year shows a little less than the average for the 10 simple engines, are about the same."

Mr. John Medway, of the Fitchburg Road, said his experience "had been largely with one 2-cylinder compound ordered with four others in 1893. The simple engines were almost precisely like the compound except with regard to the compound devices. At first the compound showed a saving of 23 per cent. in fuel. Later on, for some reason, the fuel economy was reduced and almost entirely disappeared. For the 6 months ending September, 1893, the showing was as follows: Cylinders of compound, 21 in. and 31 × 26 in.; of simple engine, 20 × 24 in. Steam pressure: Compound, 180 lbs; simple, 180 lbs. Miles run: Compound, 12,794; simple, 19,366. Miles per ton of coal: Compound, 25.1; simple, 22. Repairs, cost per mile, in cents: Compound, 2.75; simple, 1.28."

Mr. A. E. Mitchell reported that they had eight compound Baldwin engines, and that "the results show material saving in coal, no greater expense in repairs due to the running, and the engineers prefer them to the simple engine."

This discussion was resumed on the last day of the convention. Mr. A. E. Manchester, of the Chicago, Milwaukee & St. Paul Road, referring to engine No. 827, concerning which a report of tests had been submitted to the Association last year, said: "An examination of the records a few weeks ago showed the fact that No. 827 was leading the other nine engines of the same make and bought at the same time, about 11 per cent. in economy of fuel consumption. Its repair account was a trifle cheaper than the average of the other nine."

Mr. George Gibbs, also of the Milwaukee Road, referring to the same engine, said: "It was a particular child of mine, inasmuch as I have spent a good deal of time in conducting tests of that engine in connection with the Association committee. . . . I have this year been watching with some care to see whether the results of these tests were borne out by the additional service we have got from the engine. My impression was at that time, and we concluded that the average economy was about 13 per cent. . . . In the first 6 months of the year it went up to over 17 per cent. higher than the average of the other nine engines. During the last 3 or 4 months, however, I notice that it has fallen considerably, and that the figures are now as mentioned by Mr. Manchester. I believe the explanation of that is, that the valves are beginning to need overhauling. . . . I certainly believe that the compound engine is in every way adapted to a varied class of freight service; that its economy will be found larger than that found on our road in average service. I believe a properly designed compound engine will be light on repairs—as light as the simple engine—and that it is the coming type of engine for freight service in this country."

Mr. E. A. Miller, of the New York, Chicago & St. Louis Road, said: "The compound"—in use on their road—"has shown a saving of fuel of about 1 lb. of coal per car per mile. What we would call the running repairs, the light, every-day repairs, will average about the same as they do on the same class of simple engines. We have had a number of breakages on the compound that have been very much against it. The engine has been laid up a good part of the time."

Mr. William Forsyth.—"Our experience with compound locomotives is limited to very few engines, but it extends over a rather long period of time, and the conclusions in general which we made are that the repairs of the compound locomotive, when properly constructed, should not be any greater than the simple engine, and that the economy in coal should be a clear saving. The original engine which we designed and built at Aurora with the Lindner starting gear is still in service, showing good economy. The principal troubles we have had with it are with the piston packing of the large cylinder. I think that trouble has been general with most large cylinders. It is difficult to get a snap ring of good iron in proper proportion which will retain this spring and hold the packing tight; and it sometimes breaks and sometimes gets in shape so that it cuts the cylinder, and that is one trouble that we have had with this large cylinder.

"Another small objection is the difficulty in handling. That is the fault of the starting gear. The men, in running the engine on to a turn-table and out to the roundhouse, find that they cannot handle it as readily as they can the simple engine. We made quite an expensive test of a Baldwin compound, and last summer we tested a Richmond 10-wheeled compound, and I must say we were very much pleased with the performance of that engine on the grades of Iowa, hauling heavy freight trains, and that we found the special feature of the separate exhaust in that engine quite an advantage in working freight trains on a grade. It has two advantages: one is, that it allows you to turn the engine into a simple engine and overcome that objection to the Lindner gear. At the same time it allows you to throw an extra power into the engine by using live steam in the low-pressure cylinder when hauling heavy trains on grades."

Mr. G. R. Joughins, of the Norfolk Southern, reported that they had two compound locomotives on their road. "We all know," he said, "that there are about a dozen devices, each of which save about 10 per cent. on the locomotive if they are applied to it—that is, according to the statements of the people who sell them. But the compound system is the only device which I have seen applied to a locomotive which saves coal every month and every week in the year, and we are very well satisfied with it."

Mr. Bradley said they "were satisfied that their compound engines on the car mileage show about 18 per cent. of fuel economy."

Mr. David Brown.—"At Lakewood I stated that we had a Baldwin compound and a new simple engine of about the same capacity, and that the simple engine was giving the best satisfaction, and that we had given them a test on a heavy pull, also on a fast passenger train up the mountain, and also a coal test; in each case the results were in favor of the simple engine, and also that the compound was not a favorite, owing to her hard riding when running down long grades. Otherwise she has worked well.

"Our yearly report shows a great difference in cost of repairs, oil, etc., between two engines in favor of the simple engine; but this in part is accounted for, as a large per cent. of the repairs on the compound consisted in alterations.

"After 11 months of service we had to take the compound into shop on account of bad tires. The tires were in very bad shape, and we also found that the axle journals were worn eccentric, making it necessary to true up the axles. The piston valves were found in good condition; but we had to put new packing rings in both pistons and valves.

"In the mean time we received another compound from the Cooke Locomotive Works. It is a very fine engine, and I believe she is the most powerful of the three, providing she held her steam as well as the other two. It weighs 6¼ tons more than the others, and for a heavy engine the design and workmanship could hardly be improved upon. . . .

"A coal test was then made between Cooke's compound and the simple engine, which resulted in favor of the simple engine 20 per cent.

"New valves were next put on the Cooke compound with more lap. A coal test was begun between the Baldwin and Cooke engines. The Baldwin compound burned 71 lbs. of coal per mile; the Cooke compound burned 65 lbs. per mile. The difference was very slight, considering that the piston stuffing-box glands on the Baldwin engine were blowing badly at the time. The train consisted of nine milk cars and caboose.

The simple engine was then put on coal test again, which resulted in her favor, burning 52 lbs. per miles, beating the Cooke 20 per cent. and the Baldwin 26 per cent.

"An old 19 × 24 in. engine with 140 lbs. pressure, pulling eight milk cars and caboose, was next tried, and she burned 74 lbs. per mile.

"Recently the by-pass valves on the Baldwin compound have been changed, as stated by Mr. Vauclain, and it has improved her riding very perceptibly."

The most remarkable testimony was then given by Mr. Gibbs, who said that he was "very much surprised by the evidence brought out yesterday and to-day in regard to the economy of compound locomotives. If we closed now it would appear, with the exception of Mr. Brown, who has just spoken, that our unanimous experience has been that the compounds are both economical and available; *but if you buttonhole the members outside, the evidence seems unanimous in the other direction—that they don't believe in compounds.*"

Mr. W. S. Morris added: "I think Mr. Gibbs's point is a very good one. *We can hear a good deal against the compound engine outside the association, but we hear very little against it in the meeting.*"

Mr. J. H. McConnell, of the Union Pacific, stated his view of the question when he said that "when the compound engine came into existence to compete with the simple engine, they put on a boiler that had 33 per cent. more heating surface; they had 33 per cent. more weight on the driving-wheels and 33 per cent. more steam. They put it beside an engine with these disadvantages, and they claimed after 5 years to show an economy of 5 per cent. If they keep on at it long enough I believe that they will eventually get a compound engine that will beat a simple engine of the same size." (*Applause.*)

The discussion was ended by Mr. Soule, of the Norfolk & Western Road, whose careful and accurate statement of facts always commands attention. He remarked: "Mr. McConnell said in part that in every competitive test the compound had had the advantage in many respects; and that two of them, as I understood him, were, that it always carries higher steam pressure and a greater weight on the driving-wheels. I consider, Mr. President, that these are advantages that the compound engine legitimately enjoys. I believe that it is the principle of compounding that has made it possible to use higher pressures economically. I believe that if any master mechanic here present takes one of his simple engines, we will say adapted to carry 160 lbs. pressure, and builds a sister simple engine, making it only enough heavier to carry 200 lbs. pressure, and returns that engine to service in competition with the other, he will find that the latter engine with the higher pressure is not as economical as the first one. I believe it is pretty well established that the common practise of the country, by this long, slow process which we all go through with, has brought us to use that pressure in our simple locomotive practise, which is about right and about the most economical, and that we have got to the end of the rope in that matter.

"Now, then, by introducing the compound principle we are able to utilize economically higher steam pressures. In order to get those higher steam pressures we have to make our engines heavier, and, incidentally, in being able to use the higher steam pressures economically, we are justly entitled to make use of heavier weight on the driving-wheels. . . .

"We have a total of 46 compound engines, 15 of which are 10-wheel passenger engines, and 31 are consolidation freight engines. We have not been without tribulation in this matter, but we regard it as simply incidental to the struggle to get better results, which we feel we are realizing. The 15 compound 10-wheel passenger engines have large wheels. We have found during this period of depression in the last year that we have not got the passenger business to justify such an equipment. Nearly every one of these engines runs, in one direction at least, with a very light train; and we are perfectly confident that we are not deriving any advantage from their use. I think we can almost predict that we shall ultimately cut down the wheels and turn them into freight service. But we base our faith in the compound on the experience that we get with it in freight service. The first batch of 21 consolidation engines were built as recommended by the Baldwin Locomotive Works.

"We found that there was a churning action of the pistons which was damaging to the cylinders, pistons, cross-heads and guides, that arose from the fact that there is undoubtedly at times an unequal load on the high-pressure and low-pressure pistons. . . .

"But under all the varying conditions of locomotive service and all the exacting conditions on a railroad, I think that during a great portion of the time the loads on the pistons are unequal. That has shown itself in the wear of the cylinders and also in the fits where the piston-rods enter the cross head. We have recognized the fact, and in the last 10 engines have carried the low-pressure cylinder rod through to the front cylinder head. After a good many months' service from this lot of engines we think that is a solution of the problem. . . .

"Those facts and figures then presented last year brought out the fact that the expenses incidental to the maintenance of the cylinders, pistons, piston packings and valves constituted only 2¾ per cent. of the total cost of maintaining a locomotive, and, therefore, although we have had a somewhat disastrous experience with our cylinders, nevertheless it is a very slight, insignificant thing, and it is only a featherweight against the real economy that we have derived from the use of the compound principle in freight service, and that economy we believe has been established with us as ranging in the neighborhood of 10 per cent. in water consumption and 20 per cent. in coal consumption. I think we may safely assert that we have reached the point where we have got through with either building or buying simple locomotives for freight service."

We have quoted very freely from this discussion because it is a very interesting one, and the subject is of much importance to railroad companies. The preponderance of testimony brought out by the discussion, it will be seen, is strongly in favor of compound locomotives. Nevertheless, Mr. Gibbs allowed a very active animal (of the genus *Felis*) to escape from his mental sack when he testified that buttonholed members outside the meetings "don't believe in compounds." The inference is, that the unexpressed antithesis would be, that when members are unbuttoned in the meeting they become agnostics so far as compound locomotives are concerned.

On the first day of the meeting a report of the remarkable performance of simple engines on the New York Central Railroad was submitted, in a printed report in which a comparison was made with the astonishing results obtained in a test of Mr. Webb's compound locomotive *Greater Britain*, on the London & Northwestern Railroad. This data was reprinted in the American Engineer for July, page 295, but for some reason the figures submitted to the Association are not reprinted in its annual report. As the performance of the *Greater Britain*, a compound engine, is the most remarkable of which there is any record, and as it was beaten by that of a simple engine, the figures which recorded it would seem to have sufficient importance to justify their being reprinted in the annual report. The real significance of the test can be shown with a very few figures. The *Greater Britain* made a mileage of 3,612 miles, the average weight of the train of cars being 2.08 times as much as the engine and tender, at an average speed of 47.66 miles per hour, with a consumption of 2.979 oz. of coal per ton (of 2,240 lbs.) of train, exclusive of engine and tender. Engine No. 999, on the New York Central Railroad, ran 1,332 miles, the average weight of its train being 3.06 times as much as that of the engine and tender, the average speed 45.42 miles per hour, and burned only 2.18 oz. per ton per mile. Since the convention was held another test was made on the New York Central Road, a report of which was published in our issue for September, page 423. The same engine is there reported to have run 3,874 miles, at an average speed of 50.5 miles per hour, the average weight of the train of cars being 2.04 times that of the engine and tender, with a consumption of coal of 2.662 oz. per ton of train (exclusive of engine and tender) per mile.

These figures are put forward as a challenge! Where is there a compound locomotive in this country that can equal this performance? We have looked in vain for data which are comparable with these figures. In fact, none of the members who took part in the discussion in Saratoga seemed to realize the significance of the data submitted to them. If these figures can be relied on—and we understand that the authorities of the New York Central Road are prepared to back them up—then the advocates of the compound engines must, in order to sustain their claims of a saving of from 15 to 30 per cent. of fuel, be able to haul trains weighing more than twice as much as the engine and tender at average speeds of over 50 miles per hour, with a consumption of coal of 2.262 to 1.864 oz. per ton per mile. Who can do this?

Our summary has again extended to such length that we are obliged to leave the consideration of a part of the report for another occasion.

NEW PUBLICATIONS.

Advance copy of Contents and Preface of A Record of the Transportation Exhibits at the World's Columbian Exposition of 1893. By James Dredge. London: Office of *Engineering*; New York: John Wiley & Sons. 52 pp., 10¾ × 14¼ in.

The purpose of the publication of this preface obviously is to announce the forthcoming volume which Mr. Dredge has in preparation, and which will contain 800 pages and 200 plates. The preface gives an outline of the scheme, and also a general description of the plan of the Exhibition and some criticism of its merits and defects. An extended notice of the book itself cannot, of course, be written in advance. Its general scope will, however, be indicated by the following extract from its preface: "The Transportation Exhibits Building," Mr. Dredge says, "appears more deserving of having its contents specially recorded than any other department or group of the Exposition. But to adequately discharge the task a far larger volume than the present would be required. . . ."

The appearance of the complete volume will be looked for with eager anticipation by those interested in the engineering of transportation.

Machinery. Vol. I, No. 1.

In what may be called their prologue, the projectors of the new candidate for public favor which is issued by "The Industrial Press" of New York City say that "the cost of almost everything used in connection with such (newspaper) work has declined, so that it is possible to produce to-day a mechanical paper (in editions of sufficient size) for 5 cents a copy superior in every way to what would have cost twice that amount a few years ago." Therefore it is proposed to issue this paper monthly at 50 cents per year, and at 5 cents per number. With this scheme in view, they have issued a well-printed paper of 22 pages, which are a little larger than those of the American Engineer. It contains articles on the Cramp Ship Yards; Differential Gearing; Throttling *vs.* Automatic Engines; Chimney Draft; Compressed Air in a Railroad Shop; Hints for the Shop; Condensation; Threading Dies; and Notes.

The arrival of a stranger always imposes the duty of extending a welcome. In the present condition of the newspaper business this welcome, however, assumes the character which persons in prison on short allowance would be likely to give to a new convict. Even in prison, the more there are the merrier, probably, but the smaller will be the portions of food and raiment which are to be divided among all of us. Misery is proverbially fond of company, and, therefore, being in the treadmill, the arrival of another batch of convicts cheers us. The list of these includes Fred. H. Colvin, Editor; W. H. Wakeman and Walter L. Cheney, Associate Editors; and F. W. Jopling, Art Editor. We wish you all long life and greater prosperity than some of the rest of us are now enjoying.

New Roads and Road Laws in the United States. By General Roy Stone, V.P., National League for Good Roads, and U. S. Special Agent and Engineer for Road Inquiry, Department of Agriculture. New York: D. Van Nostrand Company. 166 pp., 5 × 7½ in.

The author of this book says that the demand for information on its subject generally relates:

1. To the new legislation for road improvement and the working of that legislation.
2. To the cost and methods of road construction.
3. To the efforts of road improvement where it has been accomplished.

The aim of his book, he says further, is "to give a condensed account of recent progress in American road-making, with details of the examples which have been most conspicuously successful, together with some suggestions for legislation and for road construction." The first two chapters set forth various statements and opinions to show the importance of good roads, and an explanation of the nature of the Government Road Inquiry, of which the author has been appointed the special agent and engineer. The next three chapters describe various roads built and methods of construction employed in different parts of the country. Following this are a number of chapters on Road Legislation; State and Railroad Aid in Road-making. After this Materials for Road-making; Methods of Construction; Effects of Wide Tires on Roads; Report of the Ohio Commission; Attitude of Farmers, "Wheelmen" and Commercial Organizations to the Subject of Road-making. The last chapter is on Road-making and the Revival of Business, and the book concludes with Abstracts of New Road Laws in Sixteen States. It is without an index, however—an omission which is unpardonable in any technical book. It is, however, written very clearly, is easy reading, and printed in large, clear type, and is illustrated with a number of half-tone engravings from photographs of roads in different parts of the country.

A Text-book on Roads and Pavements. By Fred. P. Spalding. New York: John Wiley & Sons. 213 pp., $7\frac{1}{2} \times 5$ in.

"The aim of this book," the author says, "is to give a brief discussion, from an engineering standpoint, of the principles involved in highway work, and to outline the more important systems of construction, with a view to forming a text which may serve as a basis for a systematic study of the subject."

There is an academic flavor about this which is not assuring, an impression which is confirmed by the opening chapter, in which the Object of Roads is gravely discussed; and we are told that "a road or street is to provide a way of travel." There is a chapter on General Considerations, another on Drainage, which is followed by one on Location of Roads, in which the reader is informed, on p. 42, that "the determination of a line for a proposed road involves the examination of the country through which the road is to pass." In reading this sage remark one is led to wonder whether any sane person ever located a road *without* examining the country. Again we are told that "changes in the length of a road affect all portions of the traffic in the same manner." How very remarkable it would be if it did not!

Evidently the author is apprehensive that roads may be located without examining the country, because he repeats the fatuous observation on page 53. On reading that "the line must be well designed to accommodate the traffic," one is disposed to ask, "What possible good can be accomplished by printing such twaddle?" The book is full of just such trite observations. The reader is informed, for example, that "footways are not required to bear the heavy loads which come upon the roadway pavement;" "a good sidewalk should present an even surface;" "curbs are usually set in the streets or towns at the sides of roadway pavements;" "there are various ways of setting a curb;" "the grades of city streets necessarily depend mainly upon the topography of the site," etc., *ad nauseam*. It may be said of this book, as of some people, it would perhaps have been better if it had never been born.

Report of the Proceedings of the Twenty-eighth Annual Convention of the Master Car Builders' Association. Held at Saratoga, N. Y., June 12, 13, 14 and 15, 1894. 468 pp., 6×9 in., and 16 folded plates.

This report reaches us in its usual form; but, like the Association and the interests it represents, it has grown in bulk, and also in the variety of matter it contains. The present volume contains 54 more pages than that of last year. It is well printed, and great credit is due to the Secretary for the promptness with which it has been issued and its general typographical excellence. In comparing it, though, with the Master Mechanics' report, several things invite comment. In the latter the reports of committees are printed in large type—apparently small pica leaded—and the discussions in smaller type—minion, also leaded. In the Master Car Builders' report this is reversed—that is, the reports and papers are printed in small type—agate, leaded—and one paper—Mr. Rhodes's on Wheel Flanges—is set in pearl leaded. The Master Mechanics' practice seems to be preferable. Agate and pearl type may do for the young chaps who are so rapidly supplanting us old fellows, but those of us whose eyesight is daily becoming less acute will vote for larger type. The general principle to be observed would seem to be to print the most important matter in the largest type. Certainly of the Proceedings the carefully prepared reports are, or may be, expected to be of greater importance than the extemporaneous discussions therein, in which such chunks of wisdom as "I second the motion;" "The convention then adjourned;" "Mr. —— read the following report," etc., form a considerable portion. If the whole of the Proceedings were printed in bourgeois or brevier, with the reports of committees leaded and the discussions set solid, the Proceedings would be pleasanter reading than they now are.

The finances of the Association would seem to admit of using a better quality of paper than the report is printed on. That which is used for both of the reports apparently consists largely of wood pulp, and its existence is probably limited to only a few years. As these reports will be valuable to posterity, it is worth while to print them on material which will not decay and crumble as early as the members of the Association will.

Another criticism is that some of the engravings—notably those of brakes, on pages 83–89—are made on too small a scale. The same thing is true of the standards of the Association at the end of the book; but copies of these are obtainable on an enlarged scale. One of them, though—that of the standard wheel tread and flange on plate 7—would be unintelligible to any person not familiar with its form and dimensions. When there is so much to commend, though, it seems invidious to criticise these minor faults.

Water or Hydraulic Motors. By Philip R. Björling. New York: Spon & Chamberlain. 287 pp., $4\frac{3}{4} \times 7\frac{1}{2}$ in.

In his preface the author says that "this book is intended as an introduction only to hydraulic motors." It is certainly a very interesting and useful introduction. It begins with a chapter on Hydraulics which gives some simple facts, principles and data which have a relation to water motors. The rest of the book relates to the following general subjects: Water Wheels; Turbines; Water Pressure or Hydraulic Engines; Hydraulic Rams; and a final chapter on Measuring Water in a Stream and over a Weir.

The author says, "All the books previously published are too abstruse in mathematics, and not practical. This," he says further, "is what I have tried, as much as possible, to avoid."

The general method of treatment of his subject is to describe very briefly, with the aid of a diagram, the various kinds of mechanism included under the different heads embraced by his book, and then give practical rules for the calculation of the proportions of the parts of the machines and the work which they would do. The general defect of the book is that the explanations of both the principles of operation and the details of construction are not full enough. More elaboration in both the illustrations and descriptions would have increased the value and usefulness of the book. Notwithstanding this defect, the reader will find—what is not common in books—that the information which he gains by reading its pages bears a very large proportion to the ground which he goes over—in other words, there is much grain and little chaff, and to get at the kernels there are no hard nuts given him to crack nor scientific and technical conundrums given him to guess, but all is made so plain that the book is almost as easy to read as a newspaper. It is brimful of interesting and useful information, which often comes to the reader in the form of a surprise. It would be interesting to know how many of the readers of this review could tell or know what the peculiarities of a Poncelet water wheel are. These are explained in a very few pages, so that the reader is never likely to forget them. The peculiarities of construction of Pelton water wheels are also described, and that there are single, double and multiple-nozzle wheels, and that with this wheel wide variations of power can be produced without essentially impairing the efficiency. This is done, first, by changing the size of the nozzle which delivers the water to the wheel; second, by a deflecting nozzle, by means of which the direction of the stream is varied; and third, by contracting or enlarging the orifice by which water is delivered to the wheel. Few American readers probably have any idea of the extent to which water-pressure engines are used in Europe, and the variety of the forms of construction which are employed, and which are described and illustrated in the book before us. The same remarks will apply to hydraulic rams. We confess that we never knew before that there are "pumping rams" which are actuated by dirty water, and raise clear water or any other liquid, fluid or semi-fluid. A number of these are illustrated and described, and apparently are in common use where the book was written. It contains over 200

engravings and an excellent index. Altogether, it is one of the kind of books which it is a pleasure and a profit to read.

TRADE CATALOGUES.

MODERN TURRET LATHE PRACTICE. Published by the Gisholt Machine Company, Madison, Wis., U. S. A. 20 pp., 7¾ × 10½ in.

This is one of the monthly publications of this company, illustrating the machines which they are making and the work which can be done on them. There are some slight indications of editorial exhaustion in this number, but, like all its predecessors, it is interesting and instructive.

HYATT ROLLER BEARING COMPANY. Powell & Colne, 107 Liberty Street, New York. 12 pp., 5¾ × 9 in.

This pamphlet describes the Hyatt roller bearing, which consists of a single ribbon of steel wound on a mandril to form a close spiral. This forms an elastic roller which, it is claimed, adapts itself perfectly to the inequalities of the axle or the bearing, and cannot be crushed or distorted by side strains on the bearing or bending strains on the journal. Various applications of this form of bearing are illustrated and described.

HEATERS. L. Schutte & Co., Engineers and Machinists, Philadelphia. 8 pp., 8¾ × 6 in.

This little pamphlet gives a description of an appliance for the noiseless heating of water by direct steam. The apparatus is briefly described as follows: "It consists of an outward and upward discharging steam nozzle covered by a shield which has numerous openings for the admission of water, so that the jet takes the form of an inverted cone, discharging upward. Air, admitted through a small pipe, is drawn in by the jet, and, by mixing with the steam, prevents the sudden collapse of bubbles and the consequent noise which is such a great objection to heating by direct steam in the old way. A valve or cock on this air pipe regulates the quantity of air as may appear most desirable.

BLOCK SIGNALING AND INTERLOCKING. A Letter to the American Railway Association. By George Westinghouse, Jr. 14 pp., 7¼ × 11 in., with large folded plate.

AUTOMATIC BLOCK SIGNALING. The Union Switch & Signal Company, Pittsburgh, Pa. 12 pp., 7¼ × 11 in., with 7 folded plates.

The first of these publications is a brief but clear description of the automatic pneumatic system of block signals and interlocking apparatus which has been developed by Mr. Westinghouse, and is now manufactured by the Union Switch & Signal Company. Without going minutely or fully into details, it describes the general principles and features of this block system so as to give a very good idea of the purposes for which it is intended and its method of operation.

The second pamphlet goes more fully into the general arrangement and application of such signals, and their operation is explained very clearly by a series of diagrams showing plans of tracks with signals and trains in the various positions which they would occupy when in operation.

Notice of a suit brought against the Hall Signal Company for infringement of patents and a list of these patents is also given. To a person wanting to get a general idea of the principles and operation of block signals without going into the details of their construction there is no publication that would be so serviceable to that end as the pamphlet before us.

COMPOUND LOCOMOTIVE. Built by the Richmond Locomotive & Machine Works, Richmond, Va. 28 pp., 6¾ × 10½ in.

The publishers of this pamphlet give, first, a very good halftone engraving of their works, with a brief description of them. Following this is a general announcement that they are prepared to build compound engines. After this are sectional views of the intercepting valve which is used, with a description of its construction and operation. Engravings follow of a simple and a compound ten-wheeled engine built by the company for the Chesapeake & Ohio Railroad, with tabular statement of dimensions, weight, etc. Another table gives the performance of 10 simple engines and one compound for a year. Indicator diagrams taken from the compound engine are also given.

Similar illustrations and descriptions of a simple and compound engine for the Cleveland, Cincinnati, Chicago & St. Louis Railway are also published, with reports of their performance. The significant figures are on the fuel consumption. On the Chesapeake & Ohio Road the simple engines ran on an average 15.22 miles to a ton of coal, and the compounds 20.46 miles, so that the compound engine did over a third more work than the simple engine with the same coal. On the Cleveland, Cincinnati, Chicago & St. Louis Road the simple engines burned 5.29 lbs. of coal per car per mile, while the compound engine burned only 3.52 lbs. This represents an economy of over 27 per cent. for the compound engine. If this rate can be maintained it must end the compound controversy, at any rate, so far as freight engines are concerned.

Another notable fact is the small difference in weight between the simple and the compounds, which in both cases is given at only 400 lbs. It would be interesting to know whether the weights given are actual weights taken from scales or "estimated." The evenness of the figures, 118,000 lbs. and 118,400 lbs. in the one case, and 135,600 lbs. and 136,000 lbs. in the other, indicates an "estimate," and not actual weights. The attitude of the writer on the subject is that of a compound *agnostic*. Perhaps from such a source—in the hope of his conversion—a little analysis and criticism may be tolerated. If the data from the Chesapeake & Ohio Road are reduced to pounds of coal consumed per car per mile, it will be found that the average consumption of 10 simple engines was 3.36 lbs. per car per mile, and that of one compound locomotive was 2.43 lbs., showing a saving of over 27 per cent. for the compound. If we take the best performance of the simple engines—that of No. 125—it will be found that it burned only 2.7 lbs. of coal per car per mile, so that, compared with it, the compound showed a saving of only 10 per cent. If, now, we make a comparison between the performance of the simple engines Nos. 108 and 125, we find that the first burned 3.93 lbs. of coal, and No. 125, 2.7 lbs. per car per mile, or a difference of 31.3 per cent.—that is, there is a difference of 31.3 per cent. between the best and the worst performance of the simple engines, and only 10 per cent. between that of the best simple engine and the compound. Now, if the smoke-stack of engine No. 125 had been painted red, by the same process of reasoning, the data before us would prove a resulting economy of 31.3 per cent. from the use of chimneys of that particular hue. All that is contended for here is that it would be fallacious, to infer from the data before us, that because the average fuel consumption of ten simple engines is 3.36 lbs. per car per mile, and that of one compound is only 2.43 lbs., that, therefore, there is a saving indicated by the difference due to the compound system. Ten compound engines working under the same conditions as the simple engines would probably show very different average results.

On the Cleveland, Cincinnati, Chicago & St. Louis Road 16 simple engines burned an average of 5.29 lbs. of coal per car per mile, while one compound burned only 3.52 lbs., which is apparently equal to an economy of over 33 per cent. Comparing the compound with the best performances of simple engines, the figures are 4.79 lbs. and 3.52 lbs., or a difference of over 26 per cent. in favor of the compound. The difference between the best and the worst performance of the simple engines is nearly 25 per cent. The point to which attention is especially called is that the reports before us show that there is as much difference in the economy of fuel consumption between different simple engines as there is between some simple and the compounds, and that the economy due to the compound system is much less than the data from the two roads referred to might indicate. We have no doubt of the fact that compound locomotives, under favorable conditions, will show some saving of fuel; but that is no reason for entertaining the belief that the saving is much more than it really is.

Accompanying their interesting publication, the Richmond Locomotive & Machine Works have issued several leaflets giving the opinions of compound locomotives which were expressed by various persons at the recent convention of the Master Mechanics' Association. At that meeting there were great differences of opinion expressed, and apparently we have not yet reached the clarifying period in the discussion when there will be abundant facts to reason from and true values will be assigned to them. In the mean while, all reports agree in this, that the Richmond Locomotive & Machine Works are building some excellent simple as well as compound locomotives, some of which are illustrated in the publication before us, the design of which can be highly commended and the performance of which is indicated by the data given in their pamphlet.

BOOKS RECEIVED.

ENGINEERING CONSTRUCTION IN IRON, STEEL AND TIMBER. By William Henry Warren. London and New York: Longmans, Green & Co. 372 pp., 8 folded plates.

A TEXT-BOOK ON ROOFS AND BRIDGES, *Part III, Bridge Design.* By Mansfield Merriman and Henry S. Jacoby. New York: John Wiley & Sons. 425 pp., $5\frac{1}{4} \times 9$ in., 18 folded plates.

STRESSES IN GIRDER AND ROOF TRUSSES, *for both Dead and Live Loads, by Simple Multiplication.* By F. R. Johnson, Assoc. M. Inst. C E. New York: Spon & Chamberlain. 216 pp., $4\frac{1}{2} \times 7\frac{1}{4}$ in.

THEORY AND CONSTRUCTION OF A RATIONAL HEAT MOTOR. By Rudolf Diesel. Translated from the German by Bryan Donkin, M. Inst. C.E. New York: Spon & Chamberlain. 85 pp., $5\frac{1}{4} \times 8\frac{1}{4}$ in., with three folded plates.

NOTES AND NEWS.

Large Steel Plate.—It is claimed that the largest steel plate ever rolled was turned out by the Wellman Iron & Steel Works, at Chester, Pa. The dimensions of the plate are 450 in. long by 130 in. wide and $1\frac{1}{4}$ in. thick. It is intended as a rudder plate for one of the vessels now being built by the Cramps for the International Navigation Company. The rudder plates called for were so large that there were only two mills in the world having sufficient capacity to make them—one at Krupp's and the other at Wellman's.

Ship Railway on the Columbia River.—An appropriation of $150,000 has been made by Congress for the preliminary work on a ship railway to be constructed through the Dalles, on the Columbia River, in Oregon. The car that will be used will be 40 or 50 ft. in breadth, and long enough to carry vessels that can steam up the river, which in the spring months, when the water is high, will allow a draft of about 14 ft. The car will be sunk under water and the vessel floated over it; the car will then be raised by a hydraulic lift some 70 ft. above the water level to the height of the land track and the car run upon it. This land track will consist of four or five railway tracks of standard gauges, and there will be no curves sharper than 2°.

The New Torpedo Boats.—The chiefs of ordnance construction and steam engineering of the Navy have completed their design for the three new torpedo-boats authorized by Congress, and it is likely that advertisements for proposals will be invited in the course of a month. The vessels will be slightly larger than the *Ericsson*, and will show several novel features, the chief of which consists in placing the propellers abaft the rudder, this experiment having been tried with success abroad. As compared with the *Ericsson*, the dimensions of the new vessels are as follows:

	New.	Ericsson.
Length load water line	160	150 ft.
Beam " " "	16	15.05
Draft " " "	5	4.75
Displacement	135 tons.	120
Indicated H.P.	2,000	1,800
Speed in knots	24.5	24
Coal capacity (tons)	50	40

A decided innovation consists in placing the quarters for officers forward and those of the men aft, which is a return of the method Ericsson pursued in designing the monitors, having particularly in mind the comfort of the enlisted men. The officers' quarters will be more roomy than those on any other torpedo boat as a result of putting the tubes above deck, while the accommodations for the men are unusually large, due to the extension of the broad water-line aft to prevent excessive squatting so noticeable in high-speed vessels. The contract price of the *Ericsson* was $113,500 for hull and machinery alone. The new vessels are limited in price to $150,000 each, including torpedo equipment and full outfit. Under the law no premiums will be paid for extra speed, but on account of the increased H.P. and finer lines of the new vessels there is little doubt that they will make 24.5 knots, which must be guaranteed by the contractor. With the exception possibly of the submarine boat, these three are the only vessels which will be commenced by the navy during the current year.

Mechanical Traction of Paris Street Cars.—Compressed air on the Mekarski system has for some time been used to drive street cars in Paris, and has been adopted on three of the lines operated by the General Omnibus Company. The longest of these is about 12 miles, and the three aggregate 24 miles. Trains of three cars, seating 51 persons each, are to start from the Louvre at quarter-hour intervals, and at a junction point are divided, one car going to St. Cloud and the other two to Sèvres and Versailles. The locomotives drawing these trains are carried on six-coupled wheels. They will weigh 18 tons, and have to surmount an incline of 1 in 28 on a part of the line. Twenty-three locomotives are to be built to operate these lines, six being kept in reserve. The air pressure carried in the reservoirs will be 1,138 lbs. per square inch, and a sufficient quantity of air will be carried to enable the locomotives to run 12 miles without recharging. The Northern Tramways Company of the same city has adopted electric accumulators for the operation of its cars. These are arranged to seat 52 persons and run at a speed of $7\frac{1}{2}$ miles inside the city and 10 miles an hour outside the barriers. The maximum grades are 4 per cent., and each car runs about 80 miles a day. The motive power is supplied by a battery of 108 cells, having 11 plates each. These cells are fitted inside 12 cases. They are coupled in four groups of 27 cells each, so that the electro-motive force of each group is about 50 volts; and as these groups may be arranged either in series or parallel, a wide range of potential is at the service of the driver. The two motors which drive the axles may also be coupled at will in series or parallel, so that a reserve of power is available for climbing grades. The total weight of the car with accumulators and passengers on board is 12 tons. Readings on a complete run showed that the average tractive effort was about $15\frac{1}{4}$ to 17 lbs. per ton, but the maximum was 80 lbs. per ton. The cost is almost the same as horse power on the same lines.

A New Russian Battleship.—On June 2 last there was launched from the yard of the New Admiralty, St. Petersburg, Russia, the great armored battleship *Sisoi the Great* (*Sisoi-Veliki*). The Emperor, the higher officers of the fleet, army and civil administration, and the whole diplomatic corps were present at the ceremony. This ship is the first of four armored ships which were laid down by the Emperor in May, 1892. The hull is constructed of steel made by the Tjora Admiralty Works in Kolpino (near St. Petersburg). It is designed on the lattice-work system, with double bottoms. The strength and security of the hull is insured by means of longitudinal and transverse bulkheads, which divide the whole space into 21 water-tight compartments. The principal dimensions of the ship are as follows: Length between perpendiculars, 332 ft.; length on loaded water-line, 345 ft.; length over all, 351 ft. 10 in.; breadth, 68 ft.; draft from 22 to 28 ft.; full displacement, 8,880 tons. The sides are vertical, being 18 ft. forward and 17 ft. aft. The fore run is straight, and provided with a cast-steel ram fastened by horizontal brackets. The after run extends vertically into the water, and at the depth of from 6 to 8 ft. it is cut away so as to form a space for the rudder and screws, which are fully protected. The rudder is of the ordinary type. The deck armor protection consists of a turtle-back deck, 3 in. thick, sloping off at the bow and stern and along the sides of the vessel. The crown of the deck at the center of the ship is 3 ft. above the water-line, while the inclination all round comes down to the sides at a point 5 ft. below the water-line. All the vital parts of the ship, such as engines, boilers, steering gear and magazines are placed beneath this deck, while immediately above it is the lower armored redoubt, 250 ft. long. The thickness of the armored plates is 16 in. The second redoubt is 60 ft. shorter. The third and upper redoubt is still shorter, and contains the additional armament of the ship. The space between the extremities of redoubts is covered with armored decks, and on the extremities of the lower redoubt armored towers are placed. These towers carry the gun turrets and establish communication with the inner rooms, magazines and stores. The diameter of the turrets is 30 ft.; height, 10 ft., and the thickness of armor plates 16 in. Each turret contains two 12-in. Oboukov guns, 40 calibers long. The height of the trunnions above the water-line is 28 ft. In addition to this armament the ship carries six 6-in. rifled guns and 18 Hotchkiss quick-firing guns. The 6-in. guns and the four of Hotchkiss guns are placed in the covered battery; the other quick-firing guns are on deck. The torpedo armament consists of six launching apparatus for Whitehead torpedoes, two torpedo-boats, and a stock of spheroconic torpedo catchers; besides these it has Boliven nets and Mangen electric projectors, in order to guard against submarine assault. Electric lighting will be used throughout the ship. The main engines are triple expansion, and consist of two independent engines of 8,500 I.H.P. There are 12 boilers of the Belleville water type with three fire boxes. The greatest speed of the ship is 16 knots. The bunkers will carry 550 tons of coal, sufficient for a voyage of 5,000 miles at a speed of 10 knots. The engines and boilers were built by the Baltic Works.

The quarters for crew and officers are very comfortable. They are high, spacious, well ventilated and lighted, because they are well up over the water-line and are provided with numerous port holes. The quarters for the crew and a portion of the officers are on the lower deck, while those for the

captain and the admiral are located astern on the upper battery deck. From the admiral's cabin a door leads to a gangway running entirely around the stern. The ship is being built by the New Government Admiralty under the superintendence of Maksinoff, as engineer, and Colonel Propoff. The whole cost will be $4,250,000. The construction was begun in 1891.

To Newark by Trolley.—A correspondent describes, in the New York *Sun*, how he went to Newark by a trolley car:

"I bought passage," he says, "at a little ticket office which stands on the sidewalk in Cortlandt Street against the side of the building on the southeast corner of West Street. For 10 cents I received two tickets, one entitling me to a ride over the ferry and the other to a ride on the electric cars from Jersey City to Newark.

"We left New York at 2.31 P.M. We started from Jersey City at 2.42 in a large open car in which there were 26 passengers. It is a familiar fact that these cars take only through passengers, but passengers are taken up by outgoing cars anywhere on the line in either terminal city, to be set down anywhere on the line in the other. . . . This car arrived at the Market Street Station of the Pennsylvania Railroad at 3.24. Time from New York, 53 minutes; time from Jersey City, 42 minutes. Time on the Pennsylvania Railroad by a train scheduled to leave New York at 2.30 from New York to Market Street, 36 minutes; from Jersey City, 21 minutes. There are trains that make the distance in less time. I stayed on the car to Broad Street and got off there, that being the point nearest where I wanted to go. Arrived at Broad Street at 3.27. Time from Jersey City, 45 minutes; distance from Jersey City about 8¼ miles. So that the actual speed of the car was at the rate of about 12 miles an hour."

Delaware & Hudson Shop Tools.—Among the handy shop tools which we have illustrated from time to time as having been designed and constructed in the shops of the Delaware & Hudson Canal Company, we show three which are especially convenient. Fig. 1 is a gauge for measuring distances between the insides of wheel flanges. The plunger at the left-hand side bears up against the spring and carries the index along the scale shown, which marks the distances between the two ends at any time. This is a very rapid and quick method of determining whether wheels have been pressed to the proper gauge or not. Fig. 2 is a handy holder for holding a reamer or tap in a drill press. The chuck is fitted into the chuck socket of the spindle and bored out straight to take the tap holder. On one side there is a slot through which a pin in the tap holder moves, allowing a cer-

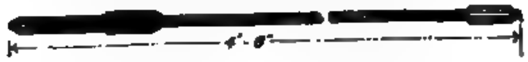


FIG. 1.

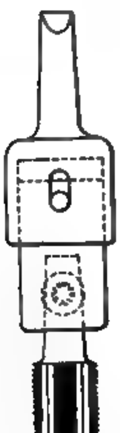


FIG. 2.

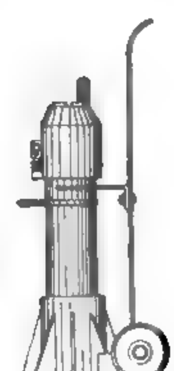


FIG. 3.

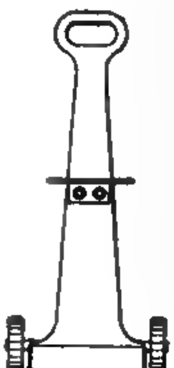


FIG. 4.

tain amount of vertical motion, so that as long as the pin is kept clear from the top and bottom of the slot there will be no tendency to cramp or pull out the socket. The tap is provided with a taper shank and is held in position by a set screw shown by dotted lines. Figs. 3 and 4 are side and front elevations of a handy little truck used for moving hydraulic jacks about the shops. As these jacks are too heavy for one man to carry, and as rolling them over the floor is a slow process, it is evident that considerable time will be saved by having a light truck on which they can be loaded and moved from one point to another as rapidly as the ordinary laborer would walk, which, at the best, is not too fast. This truck consists of a piece of iron bent to the shape shown in fig. 3 and cut out as shown in fig. 4. It has a bracket riveted to it for carrying the upper end of the jack, while the lower end is riveted to an axle carried by two smaller wheels which just touch the floor when the truck is in position, shown in fig. 3.

The Warships of China and Japan.—Since the outbreak of war between China and Japan, some particulars about the natures and relative strengths of their fleets will doubtless be of interest to some. The Chinese fleet includes 5 armored ships and 24 unarmored vessels, in addition to 24 small gun-boats and 6 floating batteries.

Name of Ironclads.		H. P.	Armor.		Date.	Speed.
			Belt.	Turret or Barbette.		
	Tons.		In.	In.		Knots.
Chen-Yuen	7,430	6,200	14 co.	12 co.	1882	14.5
King-Yuen	2,850	3,600	9½	8 "	1887	16.5
Ping-Yuen	2,850	2,400	8	5	1890	10.5
Lai-Yuen	2,850	3,600	9½	8 co.	1887	16.5
Ting-Yuen	7,430	6,200	14 co.	12 "	1881	14.5

The *Chen-Yuen* and the *Ting-Yuen* are of fair size, the others being small, and one of them, the *Ping-Yuen*, comparatively slow. They are well armed; the *Chen-Yuen* and *Ting-Yuen* have 12-in. Krupp guns, the *King-Yuen* has 8-in. and the *Ping-Yuen* 10-in. guns, besides smaller ones. Among the unarmored ships the *Chih-Yuen* and the *Ching-Yuen* are the most formidable, being of 2,300 tons displacement, 5,500 H.P. and 18 knots speed. They have 10-in. steel barbettes and three 8-in. 12-ton guns each, besides quick-firing and machine guns. The *Tshao-Yong* is a vessel of 1,350 tons displacement, 2,677 H.P. and 16.8 knots speed. She was launched in 1881, and armed with two 10 in. Armstrong guns, four 4.7-in. quick firers, and 7 machine guns. The armored ships of Japan are not formidable as ironclads. They are as follows:

Name.		H. P.	Armor.		Date.	Speed.
			Belt.	Battery.		
	Tons.		In.	In.		Knots.
Fu-Soo	3,718	3,500	[illegible]	9	1877	13.2
Hi-Yei	2,200	2,490	4½	..	1878	13.0
Kon-Go	2,200	2,450	4½	..	1877	13.7
Rio-Jo	1,459	975	4½	4	1864	9.0
Tschiyoda	2,450	5,600	4½	.	1889	19.0

as a protected
The last of these would be better described [illegible]all, weak and
cruiser than an iron-clad. The others are sm[illegible] the *Akitsu-*
slow. There are 32 unarmored ships, of which [illegible]*ma* and the
chima, the *Hasidate*, the *Itsukushima*, the *Metsuch*[illegible] one of the
Yoshino are the most formidable. The latter is [illegible] 23 knots
most rapid cruisers afloat, having 15,000 H P. and [illegible]1891, and
speed. All these vessels have been launched since [illegible] the rela-
if they come into conflict we shall be able to judge of [illegible]ers are
tive merits of armor and no armor. The Japanese crui[illegible]ny of
more numerous and larger than the Chinese, and m[illegible] that
them are model craft in the eyes of those who believe [illegible]
armored protection is not worth what it costs.—*Invention.*

A Defect in Engineering Education.—In his address before the Mechanical Section of the British Association, Professor Kennedy, the President of that Section, made the following very sensible observations with reference to one branch of the education of engineers, which it is thought is very much neglected in this country as well as in Europe. In referring to it, the professor said:

"It is not easy to overrate the importance to the engineer, as to other folk, of the power of saying clearly what he means, and of saying just what he means. I do not mean only of doing this for its own sake, but because if a man cannot say or write clearly what he means it is improbable that he can *think* clearly. By the power of expression I do not mean, of course, the mere power of speaking fluently in public—a thing which appears physically impossible to some people; I mean, rather, the power of expression in writing, which carries with it clearness and consecutiveness of thought. It is difficult to know how this matter can be taught, but at least it can be insisted upon probably to a much greater extent than is commonly the case. A man requires to see clearly not only the exact thing which he wants to say, but the whole environment of that

thing as it appears to him. Not only this, but he must see the whole environment of the same thing as it appears to the persons for whom he is writing, or to whom he is speaking. He has to see what they know about the matter, what they think, and what they think they know; and if he wishes to be really understood has got to do much more than merely write the thing he means. He has carefully to unwrite, if I may use the expression, the various things that other people will be certain to think that he means. For, after all, the great majority of people are very careless listeners and readers, and it is not for the small minority who are really exact in these matters that one has to write."

A New Elementary Body Discovered in the Atmosphere.—In describing the recent Proceedings of the British Association, a correspondent of *Nature* says:

"So far as the scientific importance of the communications made to the present meeting is concerned, it is conceded on all hands that a verbal and really an informal announcement made by Lord Rayleigh to Section B, on Monday, on behalf of himself and Professor Ramsay, takes the first place. It is known that Lord Rayleigh has been for many years engaged upon the determination of the densities of various gases. We have learned that he found in the case of nitrogen different densities amounting to about ½ per cent., according as the gas was obtained from chemical compounds and the so-called nitrogen of the atmosphere. This and other points have recently occupied the attention of both Lord Rayleigh and Professor Ramsay, and they have succeeded in isolating from this so-called atmospheric nitrogen, and by two distinct processes, a second inert ingredient denser than true nitrogen. The first method employed was that used by Cavendish in his demonstration of the composition of nitric acid. Air mixed with oxygen is submitted to electric sparks in presence of alkali until no further contraction takes place. The excess of oxygen is then absorbed by pyrogallol. That the residual gas is not nitrogen is inferred from the manner of preparation, and from the appearance of its spectrum. A second method giving much larger quantities of the new gas depends upon the removal of nitrogen from deoxygenated air by passing it over heated magnesium. When this process was allowed to continue, the density gradually rose to 14.88, 16.1, and finally to 19.09. At this stage the absorption appeared to have reached its limit, indicating that the new gas amounts to about 1 per cent. of the nitrogen of the atmosphere. When the gas thus prepared was sparked with oxygen there was little or no contraction. Lord Rayleigh and Professor Ramsay have already found that no liquefaction occurs when the gas is compressed at atmospheric temperatures.

"Sir Henry Roscoe said that the communication was one of the greatest possible interest and importance, and the Section as well as the distinguished authors were greatly to be congratulated on the announcement of the discovery of what would in all probability turn out to be a new elementary body existing in the atmosphere. The discovery appeared to him to be of special significance, as being one brought about by the application of exact quantitative experiment to the elucidation of the problem of the chemical constitution of our planet."

Pumping Air into the Earth.—What is known as the Heckert-Rowland plan for generating natural gas in the bowels of the earth is about to be given a practical demonstration in Findlay, O. The necessary pumps and engines are now being erected on the site of the old Wetherald rolling mills, in the northeastern part of the city. This is in the vicinity of several abandoned gas wells which will be utilized for conducting the experiments. The theory, which was evolved by William Heckert, a well-known mechanical engineer, at present a member of the Findlay City Council, will work a revolution in the natural gas region if it proves practical.

Heckert proposes, by means of powerful pumps, to force air down into the gas-bearing rocks, which it will permeate, and thereby become infused with the active properties of the gas itself. It is contended that as now burned for fuel, the natural gas requires an admixture of nine parts of air to one part of gas, and that this mixing can as well be done in the earth as in the stove or in the furnace where it is burned. The great trouble in the gas region is not so much the decrease in the volume of gas as the decrease in the pressure. This has fallen off in a large portion of the Ohio field, from 400 lbs., at which it started, to 40 to 80 lbs., and this is found to be insufficient to convey the gas from the wells through the system of pipes to the point of consumption. The friction takes up all the initial pressure.

By Heckert's process this lost pressure will be re-established. His air pumps, constantly at work, will force enough air down one hole to create a pressure sufficient to force the remaining gas, mixed with the air, out of several other holes, and give it a strong initial pressure in the pipes. The gas thus formed or charged with air will be ready for burning with little additional mixture of air at the point of combustion. It is also claimed by Heckert that air thus pumped down into the rock and passing over and through the pools of oil which are now almost universal in the Trenton rock in this section will take up the volatile gas of the oil and force it up the convenient wells ready for use.

Inside of a month or two the preparations for the trial of this important theory will be made.

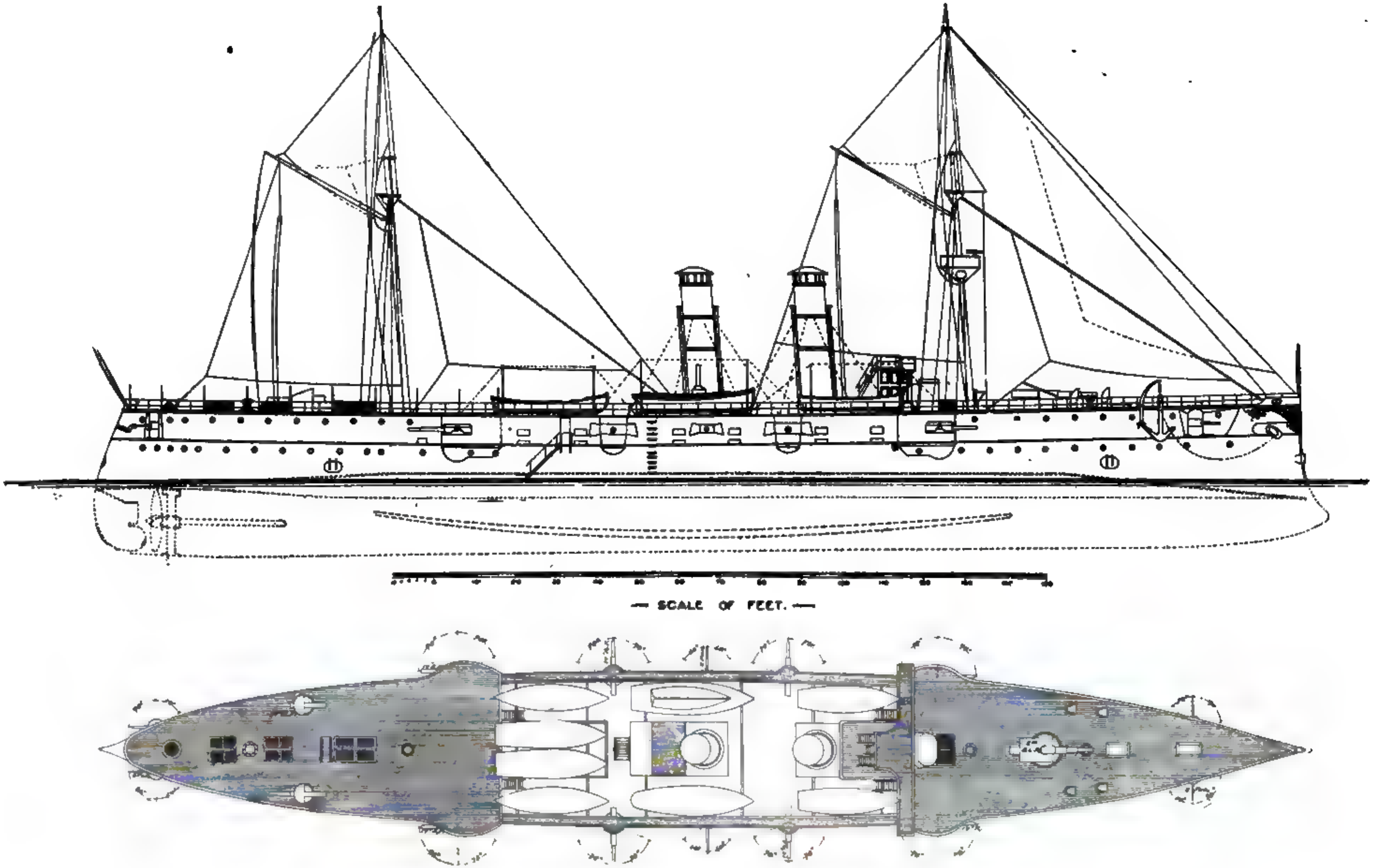
Electricity in Workshops.—A paper on this subject was read at the recent meeting of the Iron and Steel Institute, in England, by Mr. Selby Bigge, in which the author gave some interesting particulars of the progress that has been made in Belgium in using electricity as a means of distributing power in factories and workshops. The question has become one of commercial expediency, and the author boldly attacks it from this point of view, stating that his "whole contention in advocating electricity as the right and proper agent of operating new works, and as a means whereby old works can be remodeled, may be summarized by the one word 'economy.'" As an instance in point, he quoted the National Arms Factory at Herstal, near Liège. These works were recently founded to execute, in the first instance, an order for 200,000 rifles, the production being guaranteed at 250 rifles every 12 working hours. The Compagnie Internationale d'Electricité supplied the electric power installation, laying down 13 motors, ranging between 16 H.P. and 37 H.P., and giving a total of 260 H.P. For the former size of motors they guaranteed a commercial efficiency of 87 per cent., and for the latter 89 per cent. The total power of the motors (260 H.P.) would therefore be obtained by 296.9 initial H.P. There was a large amount of electric lighting to be done also, so that an engine and dynamo of 500 H.P. was installed. The ratio between the electric energy available and the energy transmitted to the shaft by the engine was guaranteed to be 90 per cent. The electric motors drive the line shafting of the machines, and the efficiency of transmission—that is to say, the ratio between the power available and the effective H.P. developed by the steam engine—is given by the product of three efficiencies, as follows: 90 per cent. for the dynamo, 98 per cent. for the conductors and 87 per cent. for the motors = 76.6 per cent. The installation has now been running for three years without being the cause of cessation of work for a single minute.

It is a very difficult matter to form comparisons between the respective efficiencies of different methods of power distribution, and it may be pointed out that in the Herstal case the electric system does not appear to its greatest advantage, as the motors drive line shafting in place of being attached directly to the machines. There is no doubt, however, that a very strong case can be made out for electricity, and electrical engineers may look forward with confidence to a large extension of their field of activity in regard to power distribution.—*Nature.*

The Extensibility of Iron and Steel.—At the recent meeting of the British Association, Professor Fidler read a monograph on this subject, of which the following abstract appeared in *Nature:*

"The author pointed out that the stress-strain diagram of ductile material as autographically drawn does not indicate any definite relation between tensile stress and plastic strain. The unit stress varies in different parts of the bar; the elongation measure by the diagram being that of the whole bar. The author's experiments indicated that the plastic extensibility under any given stress is nearly the same in all segments of the bar's length, even when the ultimate elongation varies. Volumetric measurements of the successive segments indicate that there is no sensible telescopic shear, and justify the general application of the assumption of unchanging volume. It might at first sight be supposed that a bar of uniform plastic extensibility ought to draw out uniformly over its whole length, but beyond a certain critical point a uniform extension is almost impossible. In order to illustrate these points in a bar of mild steel a diagram had been prepared. The law of plastic extension is determined by the curve, fixed mathematically the curves of the plastic limit, and it fixed also the breaking weight per square inch of original area. In regard to the possibilities of deformation in a bar of nearly uniform extensibility, as the plastic limit is approached the slightest irregularity in section or in extensibility tends to precipitate the formation of a contracted region, and beyond that limit the further extension of the bar and the further contraction of area will be confined to the same region. For stresses below the plastic limit the probabilities of deformation might be examined by considering the relative time rates of extension at two

UNITED STATES CRUISER "CINCINNATI," BUILT AT THE BROOKLYN (N. Y.) NAVY YARD.



ELEVATION AND DECK PLAN OF THE UNITED STATES CRUISER "CINCINNATI."

elements which may have been unequally stretched, and at first the tendency is theoretically in favor of preserving the cylindrical form of the bar. But beyond the plastic limit these conditions are reversed, and the tendencies are all in favor of precipitating the most rapid contraction of area at the point where any contraction already exists. Referring to the yield point, sudden elongation takes place at different stresses in the different segments, while in any one short element it seems to be instantaneous. If the yield is arrested midway and the bar examined, it may be found that the elongation has been completed in some segments and not commenced in others. In the discussion which followed, Professor Hele-Shaw pointed out that certain bronzes, unlike steel, would contract in several places at once."

UNITED STATES CRUISER "CINCINNATI."

In our issue for March, 1890, we published a short description and illustration of the cruisers Nos. 7 and 8, which had at that time just been ordered built at the Brooklyn and Norfolk Navy Yards respectively. Since that time work on these vessels has been completed, and No. 7, which was christened the *Cincinnati*, is now in commission, and has had her trial trip before the Board of Inspection.

On pages 442 and 443 we publish a half-tone and line engraving showing the appearance of the vessel as she lay at the cob dock at the Brooklyn Navy Yard, and her lines and deck plan. The vessel has a displacement of about 3,000 tons, is propelled by twin screws, and her speed is 19 knots. A complete protective deck 2½ in. thick on the slopes amidship and 2 in. on the slopes on the ends and 1 in. on the flat covers the vessel from stem to stern. Arrangements are made for storing patent fuel over the inclined parts and above it at the water-line. There is a coffer dam filled with woodite running along the ship's sides. She has a double bottom throughout, is provided with electric lights, and the ventilation is on the exhaust system. The capacity of the coal bunkers is 560 tons, and with this supply the radius of action at various speeds will be: At 20 knots per hour, 1,243 knots; at 18 knots, 2,213 knots; at 16 knots, 2,964 knots; at 14 knots, 4,190 knots; at 12 knots, 5,925 knots; at 10 knots, 8,652 knots; and at 8 knots, 9,982 knots; thus, at an average speed of 10 knots an hour, she can be kept at sea for 36 days without coaling.

The general dimensions of the ship are: Length, 300 ft.; beam, 42 ft.; displacement at a mean draft of 18 ft., 3,100 tons; the vessel is schooner rigged, and has a military top half way up each mast; the rudder is balanced and carries out the lines of the after-body of the ship.

The armament consists of one 6-in. breech-loading rifle mounted on the topgallant forecastle on a central pivot carriage; ten 5-in. rapid-fire guns mounted as follows: One on each side of the poop, and four for broadside fire on each side of the spar deck; the forward and aft guns on each broadside are sponsoned for bow and stern fire. The secondary battery consists of fourteen 6-pounder rapid-fire guns, six 1-pounder rapid-fire guns and four Gatlings. In addition to this the vessel is fitted with six torpedo-tubes, disposed one in the bow, one in the stern and two on each broadside. The engines are triple expansion, vertical, inverted, and direct acting, built rights and lefts, and placed in water tight compartments separated by a fore-and-aft bulkhead. Each high-pressure cylinder is 36 in. in diameter; intermediate pressure, 23 in.; and there are two low-pressure cylinders for each engine 57-in. in diameter. The use of two low-pressure cylinders was not due to the fact of that being the approved construction by the Navy Department, but to the exigencies of space in the engine-room. The common stroke of all pistons is 33 in. The collective I.H.P. of propelling and air-pump and circulating-pump engines is about 10,000 when the main engines are making 164 revolutions per minute with a working pressure in the boilers of 160 lbs. per square inch. All of the lower cylinder heads of the main engines are steam jacketed. The arrangement of the engines is with the high-pressure cylinder of each engine forward and the low pressure aft; the main valves are of the piston type, worked by Stephenson link motion, with double-bar links. The piston valve liners and valve gear is made interchangeable. The arrangement of valves is such that there is one piston valve for each high-pressure cylinder, two for each intermediate-pressure cylinder and two for each low-pressure cylinder. The framing of the engines consists of cast-steel inverted Y frames trussed by wrought-steel stays. The engine bed plates are of cast steel supported on wrought-steel keelson plates built in the vessel. The crank-shafts are made in two interchangeable sections and one long section. They are hollow, as are all of the rest of the shafting. Mild open-hearth steel was used for forging the shafts, connecting-rods, piston-rods and working parts generally.

The condensers are made entirely of composition and sheet brass, and have a cooling surface of about 7,000 sq. ft. measured on the outside of the tubes, the water passing through them. Each propelling engine is equipped with a double vertical single-acting air pump worked by a vertical compound engine. The circulating pumps are of the centrifugal type, and there is one for each condenser working independently. The propellers are three bladed, and made of manganese bronze, rights and lefts. In each engine-room there is an auxiliary condenser of sufficient capacity for one-half of the auxiliary machinery, and they are provided with compound air and circulating pumps.

Steam is furnished by four double-ended boilers and two single-ended boilers, that are used as auxiliaries and which are placed in four water-tight compartments. Two of the main boilers are 13 ft. 4 in. outside diameter and 20 ft. 8¼ in. long; the other two main boilers are 14 ft. 6¼ in. outside diameter and 20 ft. 8¼ in. long. The two auxiliary boilers are 11 ft. 3 in. outside diameter and 9 ft. ½ in. long; the working pressure is 160 lbs. to the square inch. Each of the main boilers of 13 ft. 4 in. in diameter has six corrugated furnace flues, made by the Continental Iron Works of Brooklyn, N. Y. These furnaces have an internal diameter of 3 ft. 4 in.; each of the other main boilers has six corrugated furnace flues 3 ft. 8 in. internal diameter, and each of the auxiliary boilers has two furnaces with an internal diameter of 2 ft. 9 in.

Measuring on the outside of the tubes, the total heating surface amounts to 19,382 sq. ft., the grate area being 597 sq. ft., which gives a ratio of 1 to 32.5. The main feed pumps are located in each of the forward and aft fire-rooms, a smaller pump being supplied for each auxiliary boiler. Each of the feed pumps, furthermore, connects with a main feed pipe, and has a capacity sufficient to supply the four main boilers when steaming at full power.

The forced draft system in each fire-room consists of a blower which discharges into a main air duct under the fire-room floors, from which a branch duct leads to the ash-pit of each furnace. Means are provided for closing the ash-pits when under forced draft, and preventing leakage of gases out of the furnace doors; the draft for each furnace being regulated by means of dampers.

Among the auxiliary machinery there is the usual steam reversing gear, ash-hoist, turning engines, auxiliary pumps, engine-room ventilating fans, engines for driving, workshop machinery, distilling apparatus, and such other auxiliary and supplementary machinery, tools and instruments as are usually required for vessels of this class.

AMONG THE SHOPS.

THE HORNELLSVILLE SHOPS.

The shops of the New York, Lake Erie & Western Railroad, at Hornellsville, N. Y., like most of the other railroad shops of the country, are by no means at present turning out all the work of which they are capable. The main machine shop is an iron and brick building equipped with modern tools, and so arranged with storage space beneath the floors that, however well the pits for the repairing of locomotives may be filled, that litter of innumerable pieces that by some skillful legerdemain must be stowed away to form the working engine does not appear, and the shop has that clean and picked-up appearance that is always so pleasing to the eye of the visitor. This storage space is an excavation 8 ft. wide and 7 ft. deep, fitted with storage shelves along one side. At present all parts are raised and lowered to and from the floor by hand tackle, but air hoists will very soon be substituted for this laborious process. A drum 3 ft. 6 in. in diameter and 18 ft. long is to be placed at the center of the storage vault to act as a reservoir for the air lifts that will be located at convenient intervals along the floor. The usual arrangement of pits, of which there are 22, on one side, and machinery on the other, with a free space down the center, is followed here. The work of the shop consists in doing the general repairs for about 225 engines, and the light repairs and furnishing the supplies for about 150 that run in daily. Among the machine tools there is a handy adaptation of an old shaper that has been converted into a grinder for guide-bars and other flat surfaces. The carriage is made to travel, while the wheel is carried on a head bolted to the old shaper head. It is a home-made tool, in which the scrap heap has been made to furnish the material, that fits so well to its new uses that it seems to have been made for it. Another tool is an attachment for grinding rocker-arm

hubs, spade-handles, and similar parts that are more or less irregular. One of the special tools that has been built for this shop is a link-grinding machine, similar in all important respects to that illustrated in the AMERICAN ENGINEER AND RAILROAD JOURNAL for October, 1893, and which has been in use on this road for a dozen years or more. The company have abandoned the use of all steam packing or packing that is set out by springs in their pistons, and now use a hollow piston with two grooves cut in the external face into which cast-iron planer is fully appreciated, and it is used on all work for which it is at all available. There are as yet no power hoists over the pits; but the work of raising those parts that cannot be located by hand into their proper positions is done by self-sustaining hoists hooked into diagonal slings swung at two or more points over the pits. At frequent intervals air pipes are led down beside the roof columns, with valves for making attachments to open furnaces that are used for heating rivets and work of a similar character.

PLOW FOR CLEARING CINDER PITS, NEW YORK, LAKE ERIE AND WESTERN RAILROAD.

packing rings are sprung. This is not only very much cheaper and lighter than the old construction, but appears to be fully as effective against leaking. The rings are split and a piece cut out, the two ends being brought up against a pin set into the groove and flattened at the sides. This prevents the rings from turning, and breaks the joints of the split. It has not only given excellent results in practice, but has served to lessen the number of piston-ring breakages, for before the adoption of the solid head there was a great deal of trouble from this

cause. While referring to the home-made tools, allusion must be made to the arrangement for grinding joints in stand, dry and steam pipes. It is nothing but an old drill press with a swinging frame added, by which the collar to be ground can be rotated and moved over the end of the pipe to which it is to fit. It has a universal motion, and does its work so easily and rapidly that it must divide the expense of making such joints by hand by from five to seven.

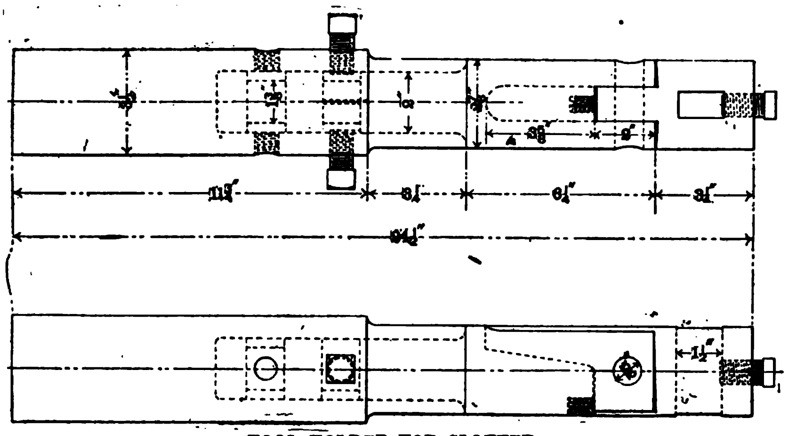
The value of the milling machine as a competitor of the planer is fully appreciated, and it is used on all work for which it is at all available.

Opening off the main machine shop is the paint shop, which has a tank or store closet that is worthy of imitation. It is purely for protection against fire and those persons who are prone to help themselves to the property of other people. It consists of a plate-iron room about 7 ft. high, 8 ft. wide and 12 ft. long. It is ventilated at the top, but the ventilator is so protected that it is impossible for maliciousness or carelessness to get fire into the place by that opening; and the entrance is

closed by a plate-iron door that is locked at night. All paints and oils are stored in this vault at night, and the oil and varnish tanks are built in permanently, so that all danger from fire is removed.

The power house is equipped with six locomotive boilers, a Corliss engine with a 17 in. × 48 in. cylinder. This engine drives all of the machinery of the machine and wood-working shops. There is also a smaller slide-valve engine driving three 10-light dynamos.

Among the buildings connected with the shops is the oil house, which is provided with an air lift very similar to that illustrated in our issue for August, as in use by the West Shore Railroad, for forcing the oil from the barrels in which it is delivered to the storage tanks. The dope used for packing oil boxes is prepared here in a large tank, of which we give a sectional engraving. The waste is dumped into one of the compartments marked "soaking," and after being covered with oil is allowed to soak for a couple of weeks. It is then ready for use, and a quantity is always kept in the draining screens for immediate delivery. In the bone yard there is a narrow gauge track of 2 ft. gauge running down between the two lines of cripple tracks. On this track there is used about the simplest type of railroad car with which we are familiar. It consists of two pairs of small wheels and axles upon which a plank is hung. It can be dismantled by one man and lifted out of the way of the regular lorrey, which bears about the same relationship to it that the vestibule limited does to the gravel train on the main line.



TOOL HOLDER FOR SLOTTER.

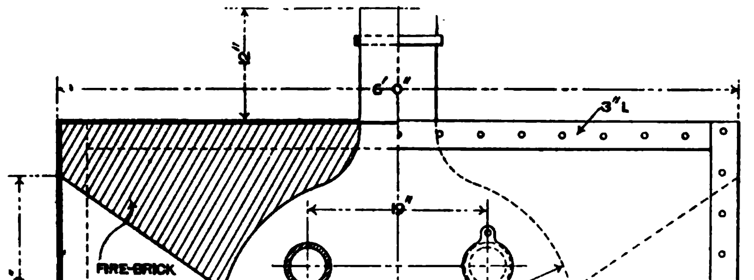
Among the labor-saving arrangements is one which we illustrate by the reproduction of a photograph. There is no drawing of it in existence, but it is simply a contrivance that has been devised by Mr. C. P. Weiss, the Master Mechanic in charge of the shops, to remove the ashes from the elevated ash-pit where the locomotives are dumped. As will be seen, it consists of a four-wheeled car that is heavily ballasted to keep it upon the rails, to which is hung a plow that can be raised or lowered according to the level of the ashes below the rails. Two pieces of railroad iron are run out from either side of the car, and to a cross-bar fastened to their outer ends the supporting bars are fastened. These latter are notched, as shown, to carry the weight, while the nose of the plow is raised by winding the chain on the rod shown at the right. The heel is hinged to the end sill by two heavy hinges, as shown, and it is thoroughly braced at the back. The materials from which this particular plow was constructed were unearthed from the scrap heap, so that the old boiler plates do not present as fine an appearance as though new material had been used. But the proof of the pudding is in the eating thereof; and as this machine will scoop 15 carloads of cinders out of the pit in 15 minutes, it may be taken to be doing fairly efficient work—at least as compared with hand labor.

AT SUSQUEHANNA, PA.

The shops at Susquehanna, Pa., are the headquarters for the great bulk of the locomotive work that is done on the New York, Lake Erie & Western Railroad. The shops are large, and the conveniences for first-class work are such that it can be done. The location is very similar to that of the Lehigh Valley shops at South Easton, Pa. The buildings stand close against an abrupt hill, while on the other side is the main line of railway running along the banks of the river. It is here that the main construction and repair shops of the road for locomotive work are located, no car work being done. A peculiarity in the arrangement of the shops is the location of the transfer table for the pits beneath the roof of the main building. Ordinarily it is not considered necessary that this appliance should be housed in, but the necessity of placing it close under the bank that rises next the shop probably influenced the builders. At any rate, there it is. It is hauled to and fro by an independent locomotive with a very broad gauge. This locomotive is also used to haul the engines on and off the table by means of a rope and snatch blocks. When idle it stands at one end of the shop with its stack beneath a telescope outlet, so as to avoid the discharge of smoke and gas into the building to as great an extent as possible.

There are 26 pits, one of which is straddled by a gallows frame used for the placing of boilers in their frames, and another is arranged with a screw drop table for removing driving-wheels. One space that might have been utilized for a pit is occupied with a lye tank for cleansing the greasy portions of locomotives that are brought in for repairs. In reviewing these shops it is unnecessary and would be uninteresting to our readers to recapitulate the tools in use; but those features of the shop which attract attention are the ones that mark the individual skill and adaptiveness of the men in charge.

Among other things, there is a joint grinder for dry pipes and other parts that has, perhaps, a wider range than the one noted in the Hornellsville shops. Like it, however, it is built of old pieces of drill presses and odd castings that have been discarded from other machines, but which could be readily adapted and fitted for this particular piece of work. It is probable that there are some machines on the market which are especially designed for doing just this class of work, but if there are we do not recall them just at present, and the skill which has been used in arranging these two tools is certainly worthy of imitation by other master mechanics. There are



CLOSED HEATING FURNACE.

also a number of small engines on trucks (most of them having been rebuilt out of old pumps), which can be moved about the shops and located at points convenient for doing such small work as drilling, reaming and tapping; there is a line of steam pipe running down the shop with valve connections at frequent intervals. By means of these connections and a hose steam is carried to the engines, and they in turn are arranged to do the work by means of a Stowe flexible shaft or a rope drive, as the case may require. These Stowe shafts are kept in the storehouse in sufficient quantities, so that they are always available for work of this character.

It is the intention to put an air compressor in the shop, to supply the compressed air, which is now delivered by two Westinghouse pumps in the tool-room. It has not yet been decided whether compressed air will be run into the steam pipes to take the place of steam in driving the small engines

or not. The reason for doing it will be that the exhaust from an air-driven engine is not as disagreeable as a steam engine, besides serving to partially cool the air in hot weather.

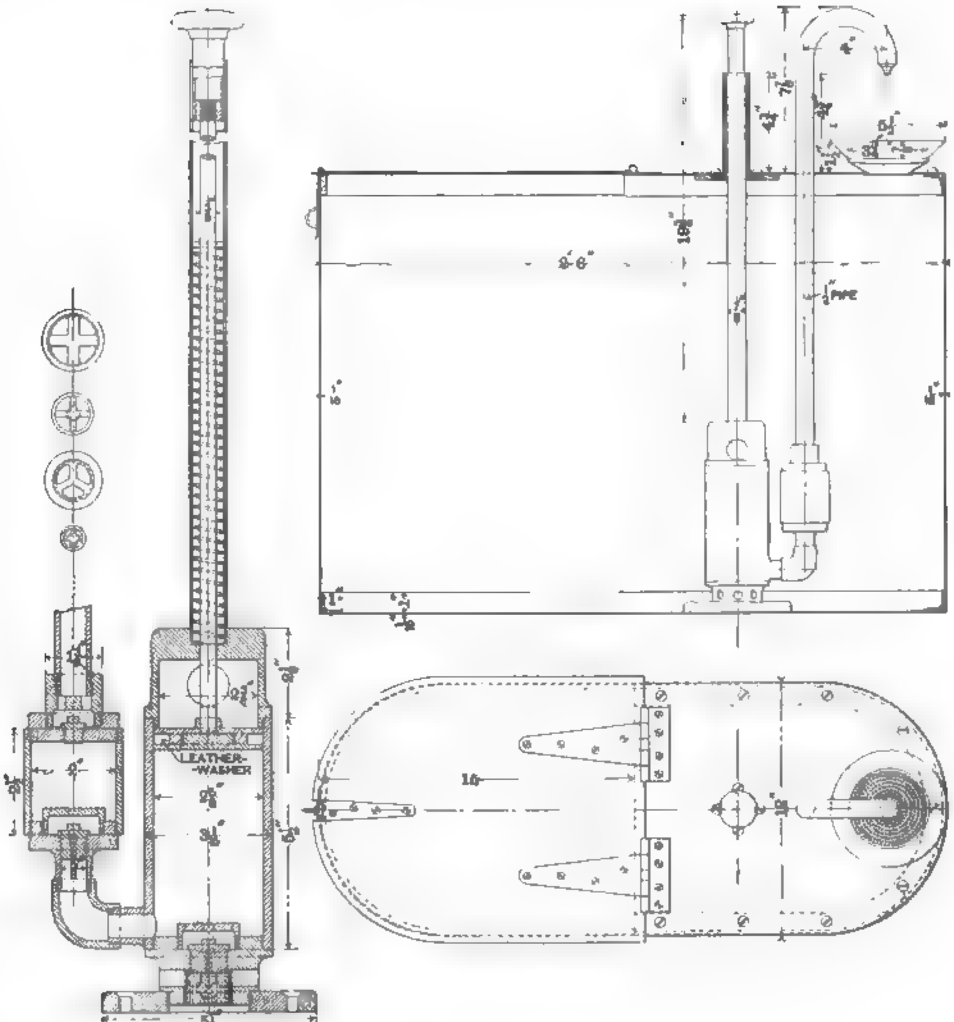
Down at one end of the shop there is a shaper arranged for testing stay bolts by a bending stress, which imitates as nearly as possible the stress to which the stay bolts are subjected by the unequal expansion and contraction of the inner and outer shells of the fire-box. The two ends of the bolts are screwed into bars threaded to receive them, and while one is held on the platen of the shaper the other is held in the head and given a reciprocating motion of ¼ in. Experiments of this kind have been in progress for some time to determine the relative durability of various metals when subjected to these stresses, but the work has not yet been carried far enough to give any definite results.

Among the novelties at Susquehanna is a small cannon for blowing out rusty bolts. It frequently happens that driven bolts rust in their places so securely that they cannot be pulled out, and their situation is such that a blow cannot be delivered upon them. Caught in just such circumstances as this, a foreman conceived the idea of using gunpowder to do the business. Accordingly a piece of car axle about 1 ft. or 14 in. long was taken, turned off, and bored out to a diameter of about 2 in. until within 2 in. of one end. A touch-hole at the breech and a vent-hole near the muzzle completed the weapon. The projectile is a plug slipping easily into the hole, flat at one end and rounded off at the other where it strikes the blow. With a light charge of powder this plug is blown against the refractory bolt with force sufficient to carry it before it, in one case carrying a footplate bolt through the cab and roof of the shop; but it has never failed to start the object it was fired at. It is a simple thing, and so cheap that the first shot will probably save enough to pay for the making.

A combination of a planer head and some additions has been evolved into a convenient little machine for milling out the ports of cylinders. A heavy casting and an arbor will soon be placed on the frame slotting machine, changing it into a heavy milling tool, with which the backs and large flat surfaces about the frames can be milled instead of being slotted or planed, thus greatly increasing the capacity of the tool.

It will be remembered that at one of the meetings of the New York Railroad Club last season the subject of taking up side play of locomotive driving-wheels was under discussion. The practice on the New York, Lake Erie & Western Railroad is to drill holes about 2¼ in. in diameter in the face of the driving boxes and fill them with projecting blocks of babbitt metal, which bear against the face of the driver and thus take up the wear. This method is giving exceptionally good results, and is cheaper in application than almost anything else which we have seen. Babbitt is also used for filling out rocker boxes, thus avoiding the necessity of supplying new boxes for those whose journals have become somewhat worn.

Another arrangement of tools foreign to their original purpose is that of a planer adapted for grinding guides, the cross feed having been modified so that the wheel is moved at each end of the stroke, the latter being carried on the cross rail and driven by a belt from overhead. Among the interesting tools which have been developed in the shop we publish illustrations of a few, the drawings of which have been kindly furnished us by the mechanical department; among these is a



PUMP AND TANK FOR FILLING OILERS.

SLOTTER BAR.

This slotter bar is in reality a tool holder for a slotter, and is so arranged that the tool drops back and clears the work after the manner of a planer tool. The upper part of the bar is 2½ in. in diameter and fits into the head of the slotter; this is bored out from below to a diameter of 2 in., as shown, and into this the tool holder is fitted, being provided with grooves, shown by the dotted lines, into which set screws are run in order to hold the bar in position. At the lower end the bar is slotted out to take the tool holder itself, which is pivoted on a $\frac{11}{16}$-in. pin at the point shown. A ¼-in. spiral spring is set over the lip of this tool holder, and as it moves upward and is dragged down this spring is compressed and allows it to drop away from the work, while on the downward thrust when cutting the strain is taken by the long arm extending up a distance of 8¾ in. above the bottom of the spring.

CLOSED HEATING FURNACE.

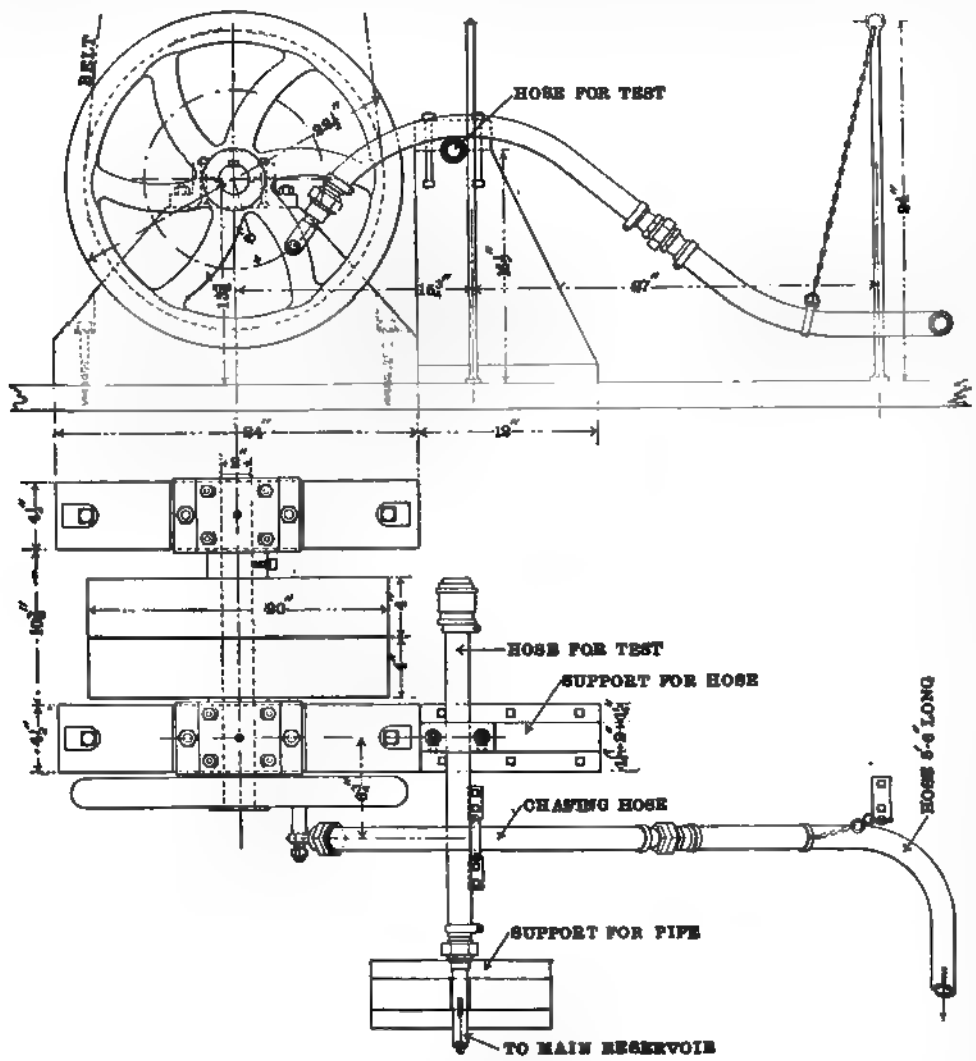
About midway down the shop stands a double-ended heating furnace for the use of the tool dresser, who dresses all the tools for the lathes and planers which are used in the machine shop. The furnace is entirely encased in iron, and occupies a floor space of 6 ft. × 4 ft., standing 4 ft. 6 in. high. The corners are bound and strengthened by angle-iron and the interior is thoroughly protected by fire brick put up in the way indicated in the engraving. A furnace thus constructed is not only very convenient for the man who is working it, but is very neat in the shop, making absolutely no smoke and no dirt that is visible, the smoke and gases being carried off in a tight closed stack.

A PUMP FOR FILLING OILERS.

Every foreman of a machine shop is well aware of the difficulties and waste which attend the filling of the oilers that are used about the machines. It is impossible to drill the ordinary man so that he will be as careful about the oil and supplies that are furnished him by the company for whom he is working as he would be if these supplies were paid for out of his own pocket. In filling the oilers, where men are allowed to do it for themselves, it is almost invariably the case that about as much oil is spilled over the outside, on the hands and floor, as is put into the oiler itself. At the same time, where men are using their oilers to any great extent, the time required to get it from the oil-room is so great that the waste would probably be cheaper than the time. In order to overcome this trouble, a tank with a pump attached has been designed, and several of them are located at different points about the shops at Susquehanna. The pump is of such a capacity that by pressing the handle down once sufficient oil will be discharged from the nozzle to just fill the oiler; and as these oilers are seldom taken to be filled until they are entirely empty, very little oil is wasted, and whatever overflow there is runs down through the strainer and back into the tank. A padlock and hasp, shown at the upper left-hand corner of the section, serves to keep the tank free from the meddling of those who would be apt to purloin the oil or drop dirt in the can. The construction is very clearly shown on our engraving. The pump proper consists of a piston without valves. It is raised to its upper position by means of a coil spring acting under the stem. A strainer is placed at the bottom of the cylinder with a wing valve above it. When the piston is pushed down the oil contained in the cylinder flows out at the bottom and through a chamber to which admission is gained through the winged valve shown at the bottom, and which is protected by a cage; these valves form the delivery valves of the discharge. The whole apparatus is so simple and its construction so clearly shown in our engraving that further comment appears unnecessary, and it is shown as a suggestion to others who wish to economize their oil and at the same time have a neat and handy apparatus by means of which to accomplish this end.

HOSE TESTING MACHINE.

When Mr. A. E. Mitchell, now Superintendent of Motive Power of the road, was Mechanical Engineer at the Susquehanna shops, it became necessary to make some tests of air hose for results beyond those usually attained by the bursting pressures. Upon observation of the hose in actual use it was noted that defective hose did not arise so much from the fact that the hose was burst by an excessive air pressure as that it would wear at those points where it comes in contact with the other hose forming the connections between the cars. It occurred to him, then, that a valuable test for hose would be the chafing test, in which one piece of hose was rubbed over another until the one rubbed gives out, the two being kept under air pressure during the process.



HOSE TESTING MACHINE, NEW YORK, LAKE ERIE & WESTERN RAILROAD.

With this end in view, he designed a little machine, shown in the accompanying engraving. The hose to be tested is capped and held in a yoke in the position shown, while the hose which is to act as a chafing hose is hung from a chain at one end and connected to the crank of a wheel driven by belt power. This chafing hose is always of one and the same make, so that no unfairness can arise in the test from one chafing hose having a greater cutting power than another. It will be seen that the hose to be tested is subjected to the rubbing of the test hose at one spot, while the latter takes the bearing over a length of about 12 in., or equivalent to the diameter through which the crank-pin moves. As we have already said, both pieces of hose are under air pressure; and when they are coupled the machine is started and run at a speed of 65 revolutions per minute. The results which have been obtained from these tests are such that it has been decided that a piece of hose must stand this rubbing test, before acceptance, for at least six hours, as this is about the average duration of samples which have been submitted for approval, although some specimens have failed in an hour and a half, while others have endured for nearly 80 hours. A marked instance of the value of this test was given shortly after the apparatus was erected. A certain hose manufacturer was unable to get his hose accepted, and objected strenuously to the validity of the test on the ground of general unfairness and inability to detect cheap from well-made hose. In order to satisfy him, he was invited to submit five samples of hose marked with letters, the key of the prices to remain in his own hands and those of the purchasing agent of the railroad, without anything being known as to the value of the hose at the shops; they were subjected to this test, and as a result the cheapest hose gave out in the shortest space of time, and this was followed by the second best, and so on up to the best and most expensive, which endured the chafing for the greatest length of time. Samples of all lots of hose received by the company are now subjected to this test, and it is considered to be the most valuable one that has as yet been devised.

ECONOMY OF DRIVING MILLS AND FACTORIES BY ELECTRICITY.

A CORRESPONDENT in a recent issue of *Indian Engineering* calls attention to the interest which exists in the use of electricity for driving individual machines of large factories, and states that the day is not far distant when electricity will become a successful rival of the old-fashioned manner of distributing power by shafting, gearing, cotton ropes and leather belting. The great losses that occur and are unavoidably present in the last-named systems are so important that it becomes a matter of serious interest to those concerned to take note of the constantly increasing application of electricity to such purposes, the use of which tends so materially to diminish the working expenses.

Having chosen the above title for our letter, and the subject being one that we have specially studied, we venture to think that a few remarks pointing out the chief advantages against the existing disadvantages of the older method will be acceptable to many of your numerous readers.

Such extremely satisfactory results have attended electrical driving in England and on the Continent, that doubtless many changes to this method of transmission of power will soon be made in India.

One great inherent advantage in using electricity is that the distributing agent—viz., the cables—conveys the power practically without loss and only in strict proportion to the demand, while in the case of mechanical transmission by shafting, etc., the loss by friction is considerable, being practically a constant quantity, whether full, partial, or light work is being done—in many cases amounting from 20 to 40 per cent. of the power available.

The longer the distance of transmission and the less the load, the greater is the proportion of loss, and in many cases this becomes a most important matter. Moreover, there is always a considerable dead weight to be rotated, the total shafting, gearing, and pulleys weighing in some cases hundreds of tons, entailing extra strength and cost in structural arrangements to withstand the strain.

From the intermittent character of the work carried out in factories and workshops, it is well known that frequently only a very small part of the power produced by the engine is actually converted into useful work at the machines.

In the present systems of mechanical driving, a single accident to the main driving-belt, shaft, or gears brings the whole establishment to rest; to obviate this is one of the chief advantages of electric transmission. A further objection to the old system is the almost insurmountable difficulties of economical extension; for instance, to increase a 500-H.P. plant to one of, say, 700 H.P. or 800 H.P. would need the almost complete substitution of new and heavier shafting, etc., and great increase in the dead load on the structure generally, while with an electrical installation little or no radical alteration is required.

In the advocated new system of driving, outside the engines or prime movers (which are neglected as being common to both systems), all the shaftings, gears, belts, bearings, etc., are replaced by simple fixed conductors of very small weight and by separate motors to each machine or tool; where, however, the power required does not warrant this, a separate motor is used to drive a group of machines from a short line of light shafting.

These shafts or groups of machines can be placed in any position found most convenient for working regardless of their neighbor.

The nature of electrical generation and dynamo working is such that only sufficient amount of current required to do the work in is used, so its economy is at once obvious.

In factories, where the machinery is working intermittently and liable to great fluctuation, the economy of working is even more marked, as the electric current can be switched on or off with the greatest ease and rapidity, after which crossed belts and fast and loose pulleys appear a heavy and clumsy, not to say unscientific, method of utilizing power.

In electrical transmission 80 per cent. of the power generated by the engine is usefully employed in the machines, and where each machine can have its own motor, a unique and highly economical method of using power is obtained.

It is hardly necessary to point out that no hard or fast law can be laid down; each case must be individually considered and that system adopted which gives the best results.

For old and existing works probably the cost of conversion would seldom be warranted, but for new factories or renovations without doubt the question of driving should be most seriously considered.

In these days of fierce competition and when profits are reduced to their lowest ebb, the careful study of every possible means of economical working is of vital importance to the manufacturers.

The use of electricity for driving all kinds of hoisting machinery is extremely satisfactory and more economical; it is easily and instantly controlled, and allows the driver to concentrate the whole of his attention to the work being handled.

For heavy machinery, such as exists in sugar works, electric driving would, without doubt, be very advantageous in effecting economy and give great convenience in working, and the facility with which electric lighting could be adopted is also an incidental but important advantage to be derived from its use.

Lastly, this system for motive power purposes lends itself most admirably to the subdivision of the motive power engines and dynamos into several units, the consequence being that by this multiplication the chances of total or even serious break-down are rendered impossible.

Before concluding we should mention that, where factories and mills, etc., are within a reasonable distance—say 10 miles of waterfalls, reservoirs, or mountain streams, when water can be relied upon, the motive power could be obtained from them with advantage by generating current at the site and distributing it to the works by the high-tension system.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.

SECOND SERIES.—CHEMICAL METHODS.

X.—METHOD OF DETERMINING COPPER AND LEAD IN PHOSPHOR-BRONZE.

BY C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST, OF THE PENNSYLVANIA RAILROAD.

(*Continued from page 378.*)

OPERATION.

HAVE ready the electrical arrangements described below, or the equivalent of these. Pour the solution of copper and lead salts obtained after the tin has been separated, as described in the Method of Determining Tin in Phosphor-Bronze, into a suitable beaker or electrolyzing jar, and dilute with distilled water to about 200 c.c. Attach the zinc pole of the battery, or its equivalent if other source of electricity is used, to the smaller central electrode, which has been previously carefully cleaned, dried and weighed, and the other pole of the battery or source of electricity to the other electrode, which has likewise been carefully cleaned, dried and weighed. Allow a current of from 0.05 to 0.10 of an ampere to pass from 12 to 24 hours. When it is deemed that the current has passed long enough, add a little water from the wash bottle, taking care not to direct the stream against the pole holding the lead, until the level of the liquid is raised a fourth or half an inch. Allow the current to pass one or two hours longer, and if the bright stem of the copper pole around which the liquid has been raised by the addition of the water, does not show any deposit of copper, it is safe to assume that all but a slight trace of the copper has been removed from the solution. The lead is much smaller in amount, and comes out more readily, and is usually all deposited long before the copper. If the stem of the copper pole shows copper when treated as above, continue the current some time longer, and then repeat the test until the stem remains clean after the current has passed at least an hour subsequent to the last addition of water. The copper being satisfactorily deposited, syphon off the liquid nearly to the bottom of the electrodes, add distilled water and syphon again until about 800 c.c. of water have been passed through the electrolyzing jar or beaker. The current should be allowed to pass during all the time of the removal of the acid, and the washing. The syphoning is perhaps best managed as follows: Have a small glass syphon with a couple of inches of soft rubber tube attached to the longer leg. Fill the syphon with distilled water, pinch the rubber tube shut, and insert the shorter leg inside the copper electrode to very nearly the bottom of the electrolyzing jar or beaker and start the syphon. When the level of the liquid has very nearly reached the bottom of the electrodes, close the rubber tube again by pinching, add distilled water by pouring it inside the copper electrode until the electrolyzing jar or beaker is nearly full again, then syphon off as before, repeating the operation until the required amount of wash water has been added. At the last

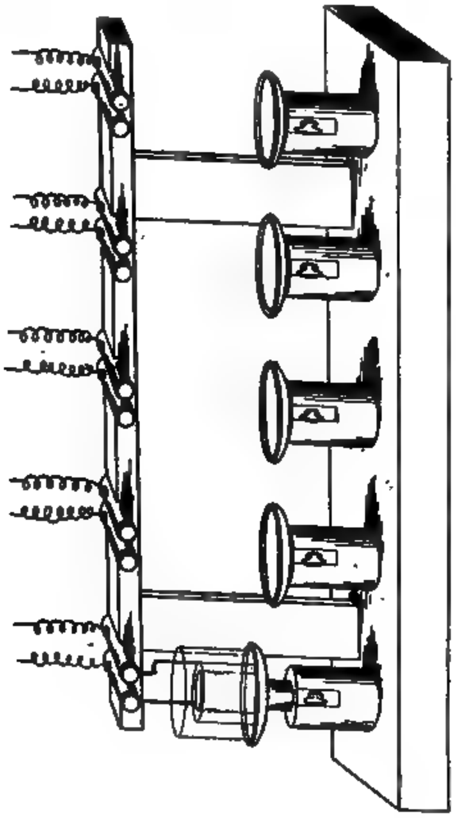


FIG. 4.

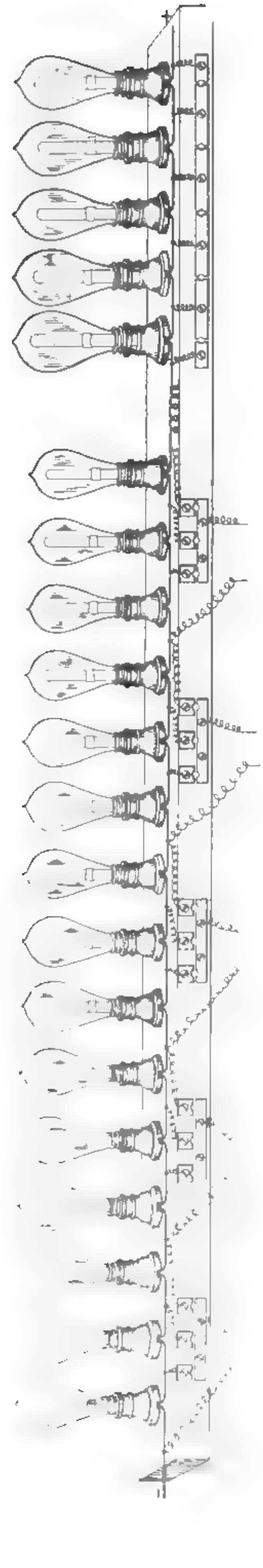


FIG. 5.

FIG. 3.

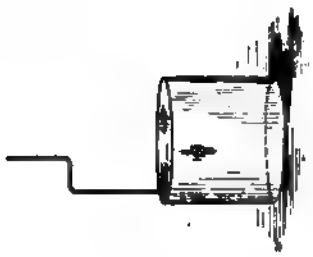


FIG. 2.

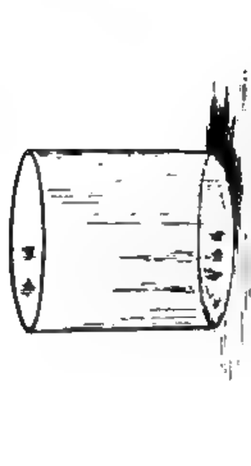


FIG. 1.

draw the liquid down so as to break the circuit. Now lower the electrolyzing jar or beaker, remove the electrode containing the lead carefully, dip it once in a small beaker containing enough distilled water to cover the cylinder, place it vertically on a clean watch glass, set in a warm place for half an hour to dry, and then put in the desiccator; allow to cool and weigh. Remove now the copper electrode, dip once in distilled water and then into a beaker containing enough alcohol to cover the cylinder. Burn off the alcohol remaining, cool in the desiccator and weigh.

If it is desired to determine the zinc and iron which may be present in the phosphor-bronze, they will be found in the electrolyzing jar or beaker and in the liquid syphoned off from this.

APPARATUS AND REAGENTS.

A small beaker about $2\frac{1}{4}$ in. in diameter at the bottom and $3\frac{1}{4}$ in. high can be used for the electrolysis; but a jar made for the purpose, shown in the cut fig. 1, of the dimensions given above, and about $2\frac{3}{4}$ in. in diameter at the top, avoids the flange and lip of the beaker, which are apt to be in the way.

The lead electrode shown in fig. 2 is a cylinder of platinum foil open at both ends, $1\frac{3}{4}$ in. high and 2 in. in diameter. The wire support is $\frac{1}{32}$ in. in diameter, and is riveted to the cylinder. It has an offset to adapt it to the binding posts of the electrical arrangement. The wire projects about 3 in. above the cylinder. This electrode weighs 15 to 18 grams.

The copper electrode shown in fig. 3 is likewise a cylinder of platinum foil open at both ends, $1\frac{1}{16}$ in. in diameter, and same height as the lead electrode. The wire support is same size wire, projects same distance above the cylinder, and is likewise riveted to it. The copper electrode weighs about 12 grams.

The supports for holding the electrolyzing jars during electrolysis are shown in fig. 4. The material, except the set screws and binding posts, is wood. The length of the base is 2 ft. and the width 6 in. That part of the support for the electrolyzing jar which has the set screw is 2 in. in diameter and $3\frac{1}{4}$ in. high. The movable part of the support for the electrolyzing jar is 3 in. in diameter at the top, and the stem is $5\frac{1}{4}$ in. long. The distance from the top of the base to the bottom of the support for binding posts is 11 in. The support for the binding posts is 1 in. thick and 2 in. wide, and the binding posts are so arranged as to support the electrodes symmetrically in the electrolyzing jar. The loose ends of the wires in fig. 4 connect with the loose ends of the wires in fig. 5.

The difference of potential between the binding posts to

which the two electrodes are attached, some two or three volts, is such that with the size of electrodes and volume of solution given above, a current of from five to eight or ten hundredths of an ampere results. This difference of potential may be obtained from a battery of two or three gravity cells; but since batteries are so difficult to keep in good order, especially if they are not in constant use, and since the Edison current is so common, it is much more convenient to use this current. But the lighting system has a difference of potential of 110 volts between the two wires, and consequently some devices are necessary to bring down the voltage. The arrangement illustrated in fig. 5 has been worked out from the suggestion given in Dr. E. F. Smith's manual of "Electro-Chemical Analysis." It is perhaps more elaborate than is necessary, but where a good deal of work must be done it has been found to be very serviceable. It is fitted up, as will be observed, to carry on five determinations at once. The base of the arrangement is of slate, 4 in. wide, 1 in. thick, and of sufficient length to carry five 16-candle-power 110-volt incandescent lamps and fifteen 12-candle-power 110-volt lamps. It is not essential to have the slate base all in one piece. It will be observed that all the lamps are connected in series, the right-hand end having the positive wire of the Edison circuit attached to it, and the left-hand end the negative. The five lamps grouped at the right of the cut are 16 candle power, and so connected, as is readily seen, with the plugging strips on the edge of the slate that any one, two, three, four, or all of them, can be cut out by simply inserting plugs in the holes made for them. The other 15 lamps are grouped in sets of three each, and are so arranged with plugging strips under each group, as is readily seen, that, when the two free wires are connected through the electrolyzing solution and a plug is in one of the three holes of the group, a shunt circuit is formed. If the plug is in the right-hand hole, the shunt circuit takes in three lamps; if it is changed into the next hole the shunt circuit takes in two lamps, and if to the next hole one lamp. This arrangement makes it possible to secure a very wide range of difference of potential at the binding posts above the electrolyzing jar. For example, if there is a plug in each of the five holes below the 16-candle-power lamps, and also one in the right-hand hole in the first group of 12-candle-power lamps, the differences of potential at the binding posts connected with this group will be about 23¼ volts. Again, if all the plugs under the 16-candle-power lamps are taken out, and the plug under the first group of 12-candle-power lamps is transferred to the left-hand hole, the difference of potential between the binding posts will be about one volt. By varying the plugging, almost any desired voltage between these two extremes can be obtained. It is evident that by using lamps of different capacity, or by using more or less of them, still wider variations of voltage may be obtained. A switch, not shown in the cut, makes it possible to shut off the current when the apparatus is not in use. It is difficult to give positive directions about the plugging necessary in using the apparatus described above, since the voltage in the mains is apt to vary a little with the distance of the apparatus from the central station; also the switch, the wires and the plugging devices used vary with the different constructions, with corresponding effect on the voltages in the shunt circuits. Still more important also is the variable introduced when one, two, three, four, or five determinations are being made at once. Each new determination introduced changes the voltage at the binding posts of all the others which are in circuit, with a consequent change in the current passing, and hence a change in the plugging becomes necessary to counteract this. The best course to pursue, if an arrangement as above described is made use of, is to connect a delicate ammeter in circuit with the determination and make a schedule of the plugging required when one, two, three, or more determinations are being made at once. It may be said, however, that if the apparatus is approximately as described above, and one or even two determinations are being made at once, successful results will be obtained if there are three plugs in the group of 16-candle-power lamps and the right-hand hole of each group of 12-candle-power lamps has a plug in it. The lamp arrangement is supported on a wooden frame not shown, with the support for holding the electrolyzing jars underneath it. It is desirable to use porcelain sockets for the lamps, as they are not corroded by the fumes in the laboratory, and of course insulated wire should be used throughout for the connections. The plugging arrangements are made of brass, and should be kept well lacquered. Turning the plugs in the holes occasionally keeps the contacts good.

CALCULATIONS.

Atomic weights used: Copper, 63.4; lead, 207; oxygen, 16; molecular formula for lead oxide, PbO_2. The copper being weighed in the metallic state, no reduction is required, consequently the per cent. or amount in 100 parts will be found by multiplying the weight found, expressed in grams, by 100. This may be briefly stated as follows: Move the decimal point of the weight of copper found, expressed in grams, two places to the right. This result will be the percentage of copper in the bronze. Thus, if the weight of copper found is 0.7964 gram, the per cent. of copper in the bronze is 79.64 per cent. The lead is weighed as binoxide; and since 86.61 per cent. of the binoxide is metallic lead, the weight found expressed in grams, multiplied by these figures, gives the amount of metallic lead in one gram of the bronze. Then the amount in 100 grams, or the per cent., will be found by multiplying this figure by 100. This may be briefly stated by the rule: Express the weight of binoxide of lead found in grams, move the decimal point two places to the right, and multiply by the decimal 0.8661. The product will be the per cent. of lead in the bronze. Thus, if the weight found is 0.1462 gram, the percentage will be [14.62×0.8661] 12.66 per cent.

NOTES AND PRECAUTIONS.

It will be observed that this method separates the copper and lead from nitric acid solution by means of electricity, the copper being thrown down on one pole in the metallic state, and the lead as binoxide on the other pole.

In order to get a proper separation of lead and copper by means of the current in nitric acid solution a certain amount of free acid is necessary. Dr. Edgar F. Smith's manual of "Electro-Chemical Analysis" states that not less than 5 per cent. is requisite. It will be remembered that 15 c.c. of concentrated C. P. acid are added on separating the tin, a little of which is probably evaporated, so that if the bulk of the solution is made 200 c.c. as directed, the amount of free acid is from 7 to 8 per cent.

Notwithstanding the amount of copper to be precipitated is quite considerable, by far the largest portion of it comes out with the appliances as described in about 12 to 15 hours, so that if a rapid result is desired it is safe to begin testing at the end of that time. When a complete analysis of a bronze is being made, the other constituents are usually not obtained sooner than 24 hours after starting, so that no loss of time results if the current is allowed to act for that time, and the certainty of getting the copper is somewhat greater with the longer time.

In burning off the alcohol from the copper electrode, no additional heat beyond that furnished by the alcohol should be used or there will be danger of oxidizing some of the copper.

The separation of the copper from the solution by the current is perhaps never absolutely complete. However long the current may be passed, it is rare that some slight reaction is not given when the acid solution is tested with hydrogen sulphide. The amount left in solution can, however, usually be ignored if the current has been passed 24 hours.

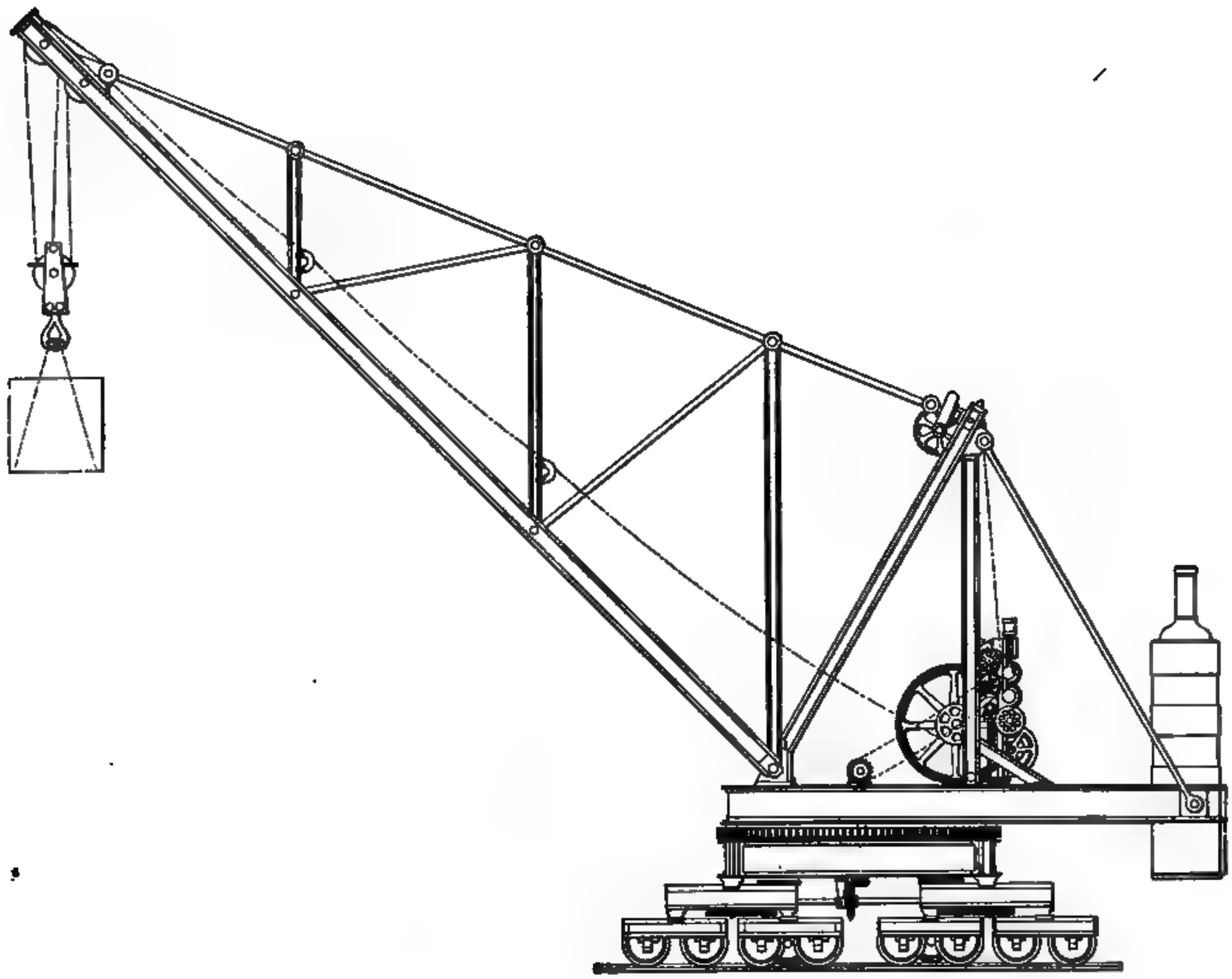
The binoxide of lead adheres to its electrode sufficiently well, so that with careful manipulation there is no danger of loss, but a direct stream of water against this electrode when the oxide is on it will detach some. A severe jar will do the same. The copper adheres well if too strong a current has not been used, and there is little danger of loss with any reasonable manipulation.

The current recommended and that given by the apparatus as arranged is somewhat greater than that stated by the authorities as proper for the precipitation of copper and lead, but no difficulties have been experienced when working with a current of 0.10 of an ampere. Indeed, at the last a still stronger current may be safely used. It is advisable at the start to use not over 0.05 of an ampere, and continue this current until the electrodes are fairly well covered. The plugging arrangement enables this to be readily done.

With a little experience the removal of the acid solution and the washing of the electrodes by syphoning as described is very satisfactory.

It is obvious, since nitric acid is present, in which copper is readily soluble, if the current is shut off before the acid is removed and the washing finished, there will be danger of loss of copper.

If there is any silver present in the bronze, which is often the case, this is thrown down with the copper and weighed as such. This error is usually ignored, the amount of silver being generally not more than six or eight hundredths of a per cent. If there is any bismuth present in the bronze, the largest part of it goes to the lead pole, causing in some bronzes quite a serious error. Consequently, if the lead found by the above-described method exceeds the limits of the specifications on which the metal was bought, a supplementary determination of the lead is always made, the lead being determined as



40-TON DOCK CRANE AT THE NORFOLK, VA., NAVY YARD. BUILT BY WILLIAM SELLERS & CO. PHILADELPHIA, PA.

sulphate before final action is taken in regard to the shipment.

The electrodes are readily cleaned after a determination is finished by immersing the cylinders in a beaker of dilute nitric acid, and allowing the two wires to touch above the beaker. A little battery cell is thus formed which soon dissolves the lead oxide and copper.

In case a little of the lead oxide becomes detached from the electrode and falls to the bottom of the electrolyzing jar, it may usually be recovered by adding alcohol after the syphoning is finished, and washing by decantation several times, and finally transferring by means of an alcohol wash bottle to a weighed watch glass, sucking off most of the excess of alcohol with a pipette, drying and weighing. The lead oxide is quite bulky, and it requires considerable of it to weigh a milligram. Of course, if any serious amount of it becomes detached, the determination should be repeated, using less current.

A small watch glass cut into two equal parts, and each one of the halves put on opposite sides of the wires of the electrodes, makes a convenient cover to keep out dust during the electrolysis.

A 40-TON DOCK CRANE.

The Navy Department have now in use at the Brooklyn and Norfolk Navy Yards a 40-ton dock crane, built by William Sellers & Co., Incorporated, of Philadelphia, which is specially intended for placing armor plates on the vessels built at these yards. The cranes are located on a track running around three sides of the dry dock, the jib of one of them being seen over the stern of the United States battle-ship *Texas*, shown in our engraving on page 149 of the issue for April of this year. The fourth side of the dry dock is left clear for the entrance of the vessel. It was an essential requirement of these cranes that they should go around curves of 84 ft. radius, measured to the center of the outside rail. This necessitated an arrangement of trucks which would compensate for this short curvature. It is very evident, also, that the crane should be capable of being moved about as the work demands, and that it should be preferably self-propelling in order that it may be perfectly independent and moved through longer or shorter distances as the proper adjustments of the plates may demand.

The tracks upon which the cranes run have a gauge of 18 ft. Our two illustrations give a very clear idea of the general appearance and construction; the line engraving having been supplied us by the *Iron Age*, while the half-tone engraving is a direct reproduction of a photograph supplied by the makers. The working capacity of the crane is 40 gross tons, at a radius of 50 ft. measured on the center line of the bearing pins of the jib, and the machinery is so arranged that it is capable of hoisting or lowering, turning or traveling, simultaneously or independently as the work may require; the machinery is also so geared that all of the motions can be readily reversed without reversing the engine. In addition to its load of 40 tons the jib is arranged to a pivot on the upper platform of the car, and is held in place by two large screws, which two can be moved so as to increase the radius of the hook 14 ft., making it 64 ft. from the fulcrum pins of the jib instead of 50 ft., and making the maximum radius from the center of the rotating platform 70 ft. instead of 56 ft. The maximum load at this radius is 30 gross tons.

The rotating platform which carries the machinery, adjustable jib and boiler, is counterbalanced at its outer end by a box containing slabs of cast iron, of a total weight of about 60 tons. This counterweight is so proportioned as to balance the loaded and empty crane, keeping the center of gravity of the mass within the circle of rollers on the crane car.

The crane is driven by a pair of 10 in. × 12 in. engines, and the various changes and motions of hoisting and lowering, turning and traversing, is accomplished by means of friction clutches. The load is also automatically sustained at all points by a patent retaining device, without attention of the operator, it being necessary to lower by power. The load is carried upon three parts of chain, the free end being wound upon the drum with a single coil without overlapping. This chain is made of tested links of 1⅜-in. round iron. The drum upon which it is wound is of wrought iron; the bearing ring for the rollers, which required a harder material, has been made of steel castings. The circular web is of two plates, and all angles are in one length, the ends of no two of them meeting in the same vertical plane.

The maximum speed of the crane is 50 ft. per minute. There are two hoists, one being a slow speed of from 5 ft. to 7 ft. per minute, while the other is a rapid hoist, for weights running up to about 15 tons, and has a speed three times that of the first. The operating clutches are arranged in pairs upon the horizontal shafts, each pair being controlled by a single lever, so that in a central position no motion will result. The forward movement of the lever will produce a corresponding motion of the crane in one direction, while the backward movement of the lever produces motion in the opposite direction. The work is thus perfectly under the control of the operator at all times and by very simple means.

Such a crane as this is not only an advantage, but absolutely necessary to an economical performance of such work as the location of armor plates and heavy work of a similar character about our battle-ships and cruisers, and this one has been so designed that its working has given the utmost satisfaction.

RECENT EXPERIENCES WITH CYLINDRICAL BOILERS AND THE "ELLIS AND EAVES" SUCTION DRAFT.*

By F. Gross.

At the last summer meeting Mr. Ellis read a paper on "Some Experiments on the Combination of Induced Draft and Hot Air Applied to Marine Boilers Fitted with Servé Tubes and Retarders." So much special attention is being given to boilers for ships at the present time, that it will perhaps interest the members to be informed of the experience which has been gained to date with this system applied to marine boilers on land and at sea. The boilers which have been working longest with this combination are at the Atlas Works, Sheffield. Nos. 7 and 8 are now three years old: Nos. 9 and 10 are two years old; Nos. 11 to 16 have since been gradually added. These 10 single-ended marine boilers, placed together in one shop, furnish part of the steam required by the works, and are at work day and night. Their ordinary work is to maintain a regular combustion due to 3 in. vacuum at the fan inlets, corresponding to a combustion of 35 lbs. to 37 lbs. per square foot of grate, which is uniformly 5 ft. 8 in. long in all the boilers. For short periods, at certain intervals during the day, the quantity of steam required is appreciably greater than the regular quantity, when, by increasing the number of revolutions, the rate of combustion is immediately raised to 40 lbs., 45 lbs., 50 lbs., or even 60 lbs. per square foot of grate, and as promptly reduced when the demand for the extra steam has passed away. It will be evident that, unlike boilers with natural draft, the boiler is the constant quantity, while the draft is varied largely according to the requirements for the time being.

For the purpose of obtaining data on suction-draft fans, different diameters and widths are used. Moreover, some fans work one boiler only, and are placed above the boilers; others work two boilers, and are placed on the ground floor, sucking the gases downward, and discharging them into short funnels, which just clear the roof of the building. The success of boilers Nos. 7 and 8 led to the construction of Nos. 9 and 10, and the satisfactory experience with the four, to the subsequent further six, partly for the sake of space, partly for economy and absence of smoke. The 10 boilers, 10 ft. 6 in. by 10 ft. 6 in., displace three to four times as many Lancashire boilers of about 28 ft. by 6 ft. 6 in., while the evaporation per pound of South Yorkshire coal is 9 lbs. actual from cold feed —or 10¼ lbs. from and at 212°—when burning at 30 lbs. per square foot of grate, or 8¼ lbs. actual feed—or 10 lbs. from and at 212°—when burning at 45 lbs. per square foot of grate, as against 6¼ lbs. actual from cold feed in the Lancashire boiler burning at 19 lbs. per square foot of grate with a chimney 180 ft. high. Very recent careful examination of the boilers shows that the Purves flues, tube plates, and Servé tube ends in the oldest are as good as new; and it is worthy of special note that the feed-water comes cold from the river, unfiltered, and that the draft is not shut off when the doors are opened for firing, slicing, or raking. The dampers are used only when the fires are being cleaned—every six hours. The fans likewise continue to work satisfactorily, as anticipated, because the gases when entering the fans do not exceed 450° at the highest rate of combustion, the air heated by the waste gases then entering the furnaces at 320°. For these boilers, owing to the steam pressure being as yet unavoidably only 50 lbs. per square inch, the fan engines are simple engines.

The International Company's steamship *Berlin* — better known under the old name of the Inman Company's *City of*

* Paper read before the Institution of Naval Architects on July 26, 1894.

Berlin—was the first steamer fitted with the draft, as conveniently as the position of the eight single-ended boilers facing the center longitudinal line of the ship permitted. The air-heating tubes had in this case to be placed across the front instead of lengthwise of the boilers, offering consequently more obstruction, with less effective heating surface, than when placed in the usual way. She has been working hard since March 1, 1893, with satisfactory results, and has burnt at an average rate of 26 lbs. per square foot of grate, 5 ft. 3 in. long.

The same owners adopted this draft for the two new steamers built in this country and recently completed—viz., the steamship *Southwark*, by Messrs. Denny, and the steamship *Kensington*, by Messrs. J. & G. Thomson, Clydebank. They are twin-screw sister ships, 480 ft. long by 57 ft. wide by 40 ft. deep. The main engines are quadruple-expansion, and intended to develop 7,000 I.H.P. in each ship at trial trip. The *Southwark* has two double-ended main boilers, 15 ft. $9\frac{3}{16}$ in. mean diameter by 21 ft. $8\frac{3}{4}$ in. long, and one single ended, 15 ft. $9\frac{3}{16}$ in. mean diameter by 11 ft. 1 in. long. Each of the five boiler ends has four Purves furnaces 3 ft. 4 in. inside diameter, grate bars 5 ft. 9 in. long. Total grate surface, 383 sq. ft. Total heat-distributing surface inside the boilers, 12,285 sq. ft. Working pressure, 200 lbs. Each boiler end has one exhausting fan 7 ft. 6 in. diameter, and separate self-acting engine by Messrs. Sturtevant, of Boston, United States, these engines being used freely in the International Company's steamers. The Servé tubes in the boilers are $3\frac{1}{4}$ in. outside diameter. At the trial trip with a displacement of 12,300 tons, she easily developed the expected power, and gave the mean speed of 16.3 knots. On her station she has been running four round voyages, Liverpool to Philadelphia, almost entirely with the two double-ended boilers only at work, with an average combustion of $27\frac{1}{4}$ lbs., which will gradually be increased. In the *Kensington* the boilers are slightly longer, the double-ended 21 ft. 7 in. and the single-ended 11 ft. 5 in. The total heat-distributing surface inside the boilers is slightly less—viz., 11,672 sq. ft. The number and size of Purves furnaces, the length of grate bars, and diameter of Servé tubes are the same as in the *Southwark*. At the trial trip, with a displacement of 12,400 tons, she gave a mean speed of 15.8 knots. She has run one voyage West so far.

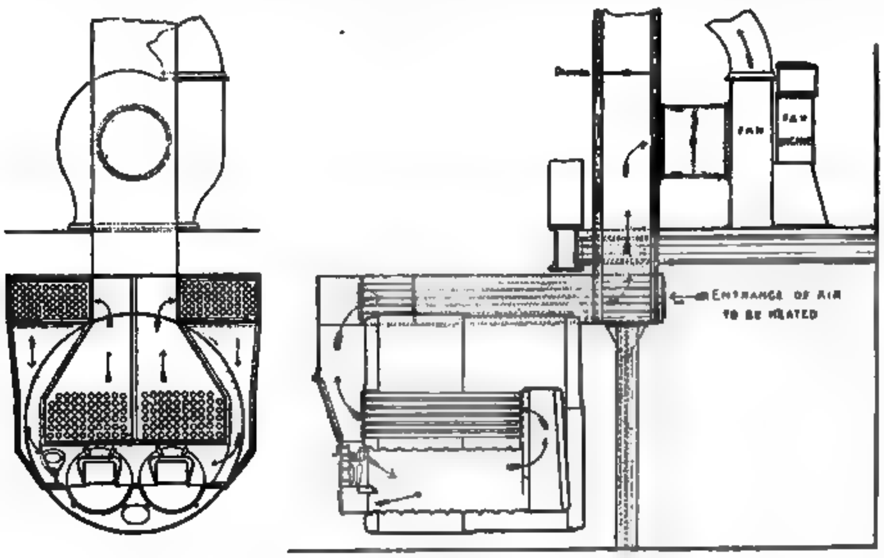
While the foregoing steamers are giving experience for the Atlantic service, two other large steamers are doing the same for the long voyages to and from Australia. Messrs. Turnbull, Martin & Co., London, in the Australian dead meat trade, have this combination draft in their new sister ships, *Perthshire* and *Buteshire*, built by Messrs. Hawthorne, Leslie & Co., Newcastle. These ships are 435 ft. long over all, 54 ft. wide, and 32 ft. deep. Displacement when fully loaded, 12,000 tons. For the power of 3,000 I.H.P. in each ship there are two single ended boilers, 15 ft. 6 in. diameter by 12 ft. long, each with three Purves furnaces, 3 ft. 9 in. inside diameter, and grate bars 5 ft. 9 in. long. Total grate surface in each ship, 127 sq. ft. Heat-distributing surface within the boilers, 4,770 sq. ft. in each ship. Working pressure, 160 lbs. The fans and triple-expansion fan engines are of Messrs. W. H. Allen & Co.'s make. Each ship has completed one round voyage to Australia and back. On the outward voyages, with an average indicated H.P. of main engines of 2,450 to 2,500, the coal consumption averages about 26 lbs. per square foot of grate. On the home voyage, requiring considerable extra steam for the large refrigerating machinery, the *Perthshire* averaged a combustion of $31\frac{1}{4}$ lbs. over nine consecutive days, and the *Buteshire* $27\frac{1}{4}$ lbs. per square foot of grate over 56 consecutive days. The coal consumption of Newcastle small coal on the outward voyages averages 1.345 lbs. per indicated H.P. of main engines. This includes the power required by the fan engines. With South Wales coal the consumption of main engines will, therefore, be under 1.8 lbs. per indicated H.P., after finding the power for the fan engines. Although the boilers of the *Perthshire* had been continually under steam for 75 days, being worked for 59 days at this, for Australian voyages, unprecedented rate of combustion, the furnaces, tube plates, tube ends, and the fans were found in good order on arrival in London. These owners are fitting the draft arrangement to a third sister ship, the steamship *Banffshire*, now building by Messrs. Hawthorne, Leslie & Co.

PARTICULARS OF SHIPS AT WORK WITH THE "ELLIS & EAVES" COMBINATION DRAUGHT.

	S.S. Berlin.	S.S. Southwark.	S.S. Kensington.	S.S. Perthshire.	S.S. Buteshire.
Length of ship	488 ft. 6 in.	480 ft.	480 ft.	435 ft.	435 ft.
Width " "	44 " 0 "	57 "	57 "	54 "	54 "
Depth " "	36 " 9 "	40 "	40 "	32 "	32 "
Displacement at trial trip—tons	....	12,300	12,400	7,500	. ...
Number of boilers	8 single-ended.	2 double-ended and 1 single-ended.	2 double-ended and 1 single-ended.	2 single-ended.	2 single-ended.
Size " "	13 ft. $2\frac{1}{2}$ in. mean diam. × 11 ft. $4\frac{1}{2}$ in.	15 ft. $9\frac{3}{16}$ in. mean diam. × 21 ft. $8\frac{3}{4}$ in. 15 ft. $9\frac{3}{16}$ in. mean diam. × 11 ft. 1 in.	15 ft. 9 in. mean diam. × 21 ft. 7 in. 15 ft. 9 in. mean diam. × 11 ft. 5 in.	15 ft. 6 in. mean diam. × 12 ft.	15 ft. 6 in. mean diam. × 12 ft.
Number of furnaces	24	20 Purves.	20 Purves.	6 Purves.	6 Purves.
Inside diameter of furnaces	3 ft. 2 in.	3 ft. 4 in.	3 ft. 4 in.	3 ft. 9 in.	3 ft. 9 in.
Length of grate	5 " 3 "	5 " 9 "	5 " 9 "	5 " 9 "	5 " 9 "
Total heat distributing surface in boilers, reckoning outside surface of tubes	14,616 sq. ft.	12,285 sq. ft.	11,672 sq. ft.	4,770 sq. ft.	4,770 sq. ft.
Total grate surface	396 "	383 "	383 "	127 "	127 "
Working pressure	150 lbs.	200 lbs.	200 lbs.	160 lbs.	160 lbs.
Number of fans	4	5	5	2	2
Size " "	7 ft. 6 in. diam.	7 ft. 6 in. diam.	7 ft. 6 in. diam.	8 ft. diam.	8 ft. diam.
Mean speed developed at trial trip—knots	....	16.3	15.8	11.75	....
Average revolutions of fan engines	360	317	....	320	....
Number of voyages	17	4	....	1	....
Average I. H. P. of voyages	5,566	4,446	....	2,450 outwards.	....
" coal consumption per I. H.P.	....	....	....	1.34 lbs. Newcastle Sm.	....
Temperature of air before entering furnaces	260°	271°	....	220°	....
Temperature of gases at fan inlet	441°	393°	... .	310°	....
Vacuum at fan inlet	3.5 in.	2.9 in.	....	1.75 in.	....
" over fires	1.1 "	.8 "	....	.2 "	....

Briefly summarized, the experience to date may be considered to have established a rate of combustion on a grate 5 ft. 9 in. long of 30 lbs. to 60 lbs. in marine boilers on land, and of 26 lbs. to $31\frac{1}{4}$ lbs. at sea in the Atlantic and Australian services, without trouble to furnaces, tube plates, tube ends, fans and fan engines, accompanied by an appreciable economy compared with the boilers of the same size with plain tubes working with natural draft at half the rate of combustion. The main factor in the economy is, of course, the Servé tube in combination with the retarder, because the Servé tube has on an average at least 75 per cent. more heat "absorbing" surface than the same diameter of plain tube. The result is that at the highest rates of combustion, and with $3\frac{1}{4}$ in. diameter tubes—permitting natural draft to be readily used—the gases, when they reach the smoke-box, do not exceed 700°. The heat-absorbing surface of the air-heating tubes completes the economy, the gases reaching the fans cooled down to 300° to 400°, having heated the air to from 200° to 300°, according to the rate of combustion and amount of absorbing surface. Against close stokehold forced draft, burning at the same rate of combustion with plain tubes, the weight of the boilers with this system will be greater, but there is a considerable net saving in weight for other than short cross Channel voyages through the economy in fuel, which is naturally greatest against closed stokehold cold-air draft. At a combustion of 30 lbs. per square foot of grate this economy will be at least 15 per cent. Against Mr. Howden's latest practice the loss of weight is trifling, being practically only the extra weight of the ribs in the Servé tubes and of the greater surface of the

air-heating tubes, and these produce a distinct advantage in economy in fuel of at least 7½ per cent. In a number of steamers working with Mr. Howden's draft, the substitution of Servé tubes for plain tubes has at once given an economy of 10 per cent., and it will be conceded that the horizontal air-heating tubes in the suction draft will be more effective than vertical tubes. Even with natural draft, with a funnel height of 75 ft. or more, the Servé tube has proved in a considerable number of vessels that it gives an economy of 10 per cent.



BOILER WITH ELLIS & EAVES' HOT-AIR AND SUCTION SYSTEM.

over plain tubes in the same boilers, and the special advantage of this suction-draft combination is to give the same economy when burning at twice the rate in half the number of boilers, or to make the steam as economically as is now done with natural draft and plain tubes when burning at three times the rate in one-third the number of natural-draft boilers.

Taking, therefore, boilers and coal together, this system requires in reality for moderate and long voyages the least weight of cylindrical boiler for a combustion of 25 lbs. per square foot of grate and upward: and, as the action of the suction-draft is to heat the boilers more uniformly the higher the rate of combustion—therefore the opposite of forced-air pressure draft—it is probable we shall gradually see the boilers reduced more and more in size, and the rate of combustion at sea increased to 40 lbs., 50 lbs., and upward per square foot of grate. Electric motors with small fans will assist in this direction, and the economy, safety, and comfort of this system in working are strong recommendations for large passenger and cargo boats, while for warships the power to do away entirely with smoke, and even with funnels, should not be without importance. The accompanying table gives the principal data for the five ships grouped together for handy reference.

PROGRESS IN GAS MOTORS FOR STREET RAILWAYS.

In a recent issue of the United States Consular Reports Mr. Frank H. Mason, our Consul-General to Frankfort, contributes the following interesting information on the subject of gas motors for tramway purposes. Referring to the Lührig model of a street car propelled by a gas engine, and carrying its supply of compressed gas in cylindrical reservoirs hung beneath the floor of the vehicles, he says that, although of recent invention and somewhat complicated in construction, this car had been worked successfully in Dresden at a net cost of operation so far below that of electric or even horse railways that it seemed to embody the germ at least of a new and important departure in street railroad equipment, particularly for the large class of lines whereon traffic is limited and varies essentially in volume at different seasons or hours of the day. Through the death of the inventor and other circumstances, the ardor of improvement appears to have been temporarily checked in Germany, and the field of experiment has been transferred to England, where the Lührig patents have been acquired by a syndicate, and the car has undergone, during the past four or five months, modifications which, from trustworthy accounts, have greatly lessened its weight and cost and enhanced its practical value.

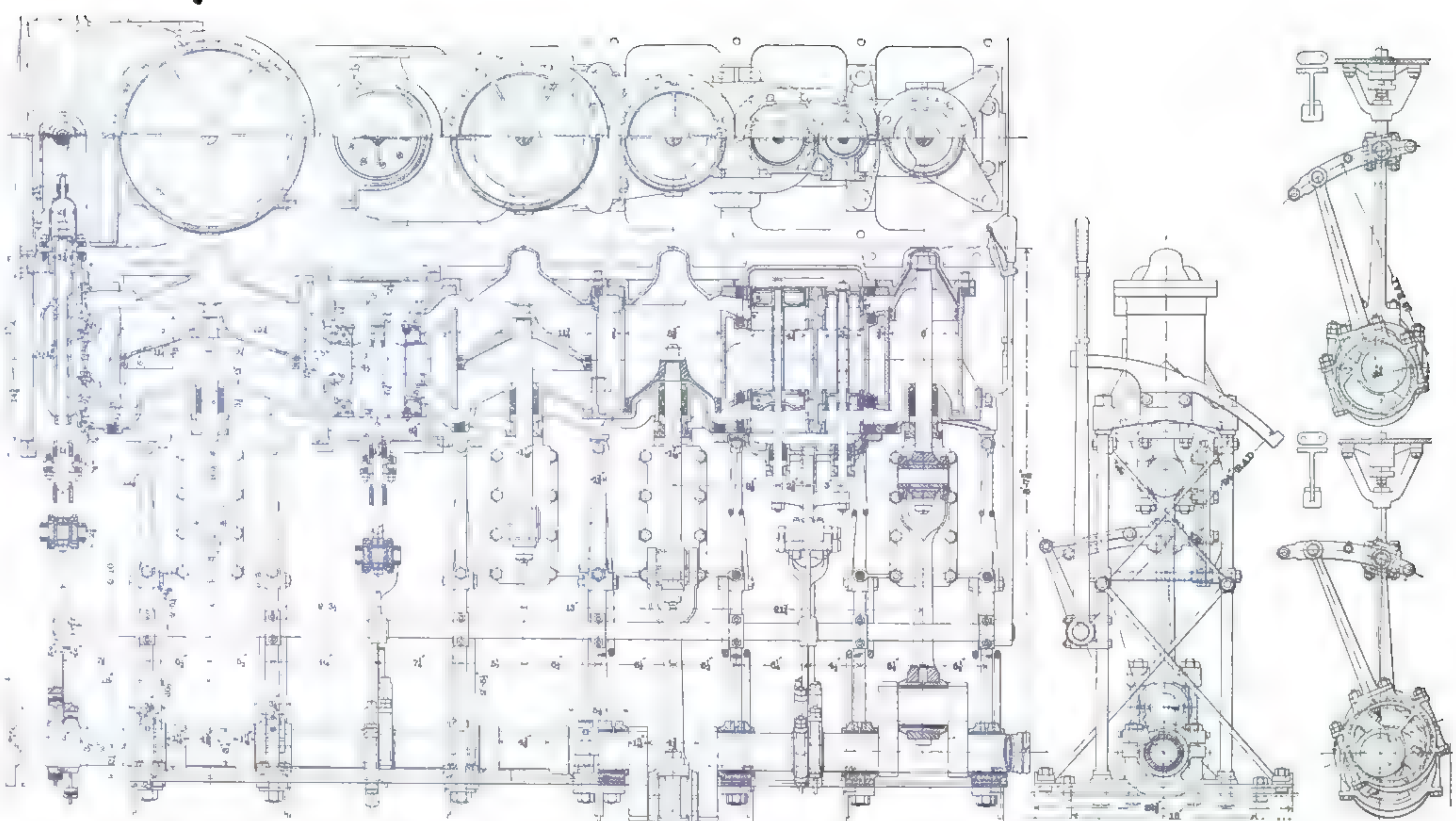
A car of this improved type is now worked regularly on the lines of a tramway company at Croydon, near London, and has attracted expert attention from all parts of Great Britain, where the problem of street railway equipment and management is quite as complicated and difficult as in any portion of the United States. Not less than $70,000,000 is invested in tramway lines within the United Kingdom, with results so generally unsatisfactory, as regards profits to stockholders, that there is a wide and urgent demand for a new and simplified motor or system that will secure equal effectiveness and greater economy in operation. Notwithstanding the relatively dense population of Great Britain, only a small proportion of its tramways, as worked at present by cables, steam locomotives, electricity, or horse power, are really satisfactory to the public or pay regular dividends. The same need exists there, as elsewhere, for a motor which shall be clean, noiseless, manageable, independent of overhead wires or underground constructions, and withal so cheap in initial investment and working expense as to successfully supersede horse cars, to which there are many objections on the score of cleanliness, speed, and economy on lines which have a light or varying volume of traffic.

One important difficulty in the case of every self-contained car lies in the fact that, for climbing grades, starting under full load, passing curves, or meeting sudden falls of snow, a car which, when in motion, can be easily drawn by two horses must be equipped with a motor capable of exerting temporarily 10 or 12 H.P., and for this a considerable weight of machinery is unavoidable. The general defect which has been found in gas motors for street railway purposes hitherto has been that they have been available only for light traffic, and, if made sufficiently powerful for city lines, their excessive weight and cost would form a fatal objection.

Through the modifications which have been made in the Lührig motor car by the English engineers, these defects are believed to have been practically overcome. The original car was rigged with two double-cylindered gas engines, one under each seat, and both working upon the same driving shaft, and weighed, without passengers, 7½ tons. In the improved car but one gas engine is used, the two cylinders of which are set facing each other, and both working to the same crank. The engine is located under the seat on one side of the car; the other end of the driving shaft, which extends across beneath the floor of the vehicle, carrying a fly wheel, which steadies and regulates the motion of the engine. By this improvement the number of working parts, and, therefore, the weight, cost, and wear and tear of the motor, have been greatly reduced. What is equally important, in a commercial sense, the motor has been reduced to a form and dimensions which will permit it to be adjusted to cars already built for cable, electricity, or horse power.

But by reducing the engines to one, the power of the car to start promptly with a heavy load was compromised, and this weakness has been overcome by the momentum of the fly wheel and by the device of keeping the engine constantly in motion while the car is in service and transmitting its power from the crank shaft, through a second-motion shaft, to the running gear by friction clutches under the control of the driver. This is arranged as follows:

The driver, standing on the front platform, has before him the brake wheel, and beside him a movable lever not unlike the reversing bar of a locomotive. When this lever is in a vertical position the engine shaft is disconnected from the second-motion shaft and the axles, so that the car may be at rest while the engine is running free. When the lever is pushed to the right the second-motion shaft, with which the axles are connected by chain gearing, is brought into engagement by a pinion and friction clutch, which gives the car a speed of 4 miles per hour. Shoving the lever to the left brings into similar engagement a larger pinion, which, without changing the



QUADRUPLE-EXPANSION ENGINE FOR THIRD-CLASS TORPEDO BOAT FOR THE UNITED STATES BATTLESHIP "MAINE."

speed of the engine, gives the car a pace of 8 miles an hour, which is the limit of speed allowed by the municipality of Croydon. A second lever is provided for operating reversing clutches whenever, at the end of the line or elsewhere, the movement of the car has to be reversed. The friction clutches, which form so important a feature of the machine, are made of hard wood set between the two disks of iron, and are said to be effective and durable.

There must be, of course, some device to regulate the speed of the engine and keep it as nearly as possible uniform while the car is stopped and under the varying conditions of grade and load. This has been provided for with great ingenuity—first, by a governor, which, when the work is light, cuts off automatically the gas supply from one of the cylinders, leaving the other to do the work alone, and, still further, through a mechanical connection between the governor itself and the lever, already described, which operates the clutches. When this lever is upright and the engine shaft disengaged from the axle gearing, a weight on the spindle of the governor is lifted which cuts off the gas at half stroke in the one working cylinder, so that, while the engine is running free with the car at rest, it is reduced to half speed, and the explosions are rendered so light and gentle as to be hardly perceptible.

Ordinary street gas is used, condensed to a pressure of 10 atmospheres, and the reservoirs under the floor of the car, which can be filled through a flexible pipe within the time required to change horses, carry gas enough for a run of 8 or 10 miles. The consumption of gas by a loaded car is stated to be 25 cub. ft. per mile, which costs at Croydon 2 cents. The syndicate under whose management the car now in service has been built and tested is naturally disinclined as yet to disclose fully the detailed results, but the editor of *Engineering*, who has been permitted to examine the experiments somewhat carefully, states his conclusions as follows:

"The car is not noticeably different from a horse car. It runs quietly and easily, emitting neither smoke nor steam, and is quite under control. Inside passengers can hear a slight rumble of machinery and perceive a trifling vibration; but after a minute or two these are unheeded, and practically there is nothing to detract from their comfort. Neither they nor the bystanders in the street can perceive any machinery whatever, for the engine and gearing are entirely inclosed, the motor lying under one seat and the wheels and clutches under the floor of the car. . . . It carries twenty-eight passengers in all, and makes a very fair speed, the limit allowed by the Board of Trade being 8 miles per hour. With the slow gear in action it will readily mount an incline of 1 in 28, with a short piece of 1 in 16, and in coming down it can be stopped by the brakes in its own length. It also goes round a curve of 35 ft. radius on a 1 in 27 grade. Its weight, when filled with passengers, is 5¼ tons. For gas it costs 1*d*. (2 cents) per mile, against 3½*d*. (7 cents) per mile for fodder and bedding for horses; so that the gas-motor car starts with an advantage of 2½*d*. (5 cents) per mile. The performance of the car is quite satisfactory."

The main question, which remains to be decided by prolonged experience, would seem to be that of net cost of maintenance. The initial cost of the motor car is about the same as that of an ordinary horse car, and the eleven horses which are required on well-managed lines to operate it. The point to be determined is, whether it is or is not cheaper to keep one gas engine in order than to keep in health and serviceable condition eleven horses, and whether the machine will last longer in service than the animals. When the motor car is not needed it costs nothing but a shed to shelter it, while the horses must be fed and cared for. From the English standpoint, the horse car is the only system that offers any serious competition with gas, and, as the latter starts with an advantage of 5 cents per mile in the cost of material consumed, its victory on a large majority of the lines in that country would seem to be more than probable.

A special motor car of the type above described, combining all the improvements thus far made and reduced to the utmost limit of simplicity and lightness, is now being constructed in England, to be carried to the United States for exhibition and trial in October. Its performances will doubtless merit the attention of all who are interested in the complicated subject of city and suburban transportation.

QUADRUPLE-EXPANSION ENGINE FOR THIRD-CLASS TORPEDO-BOAT.

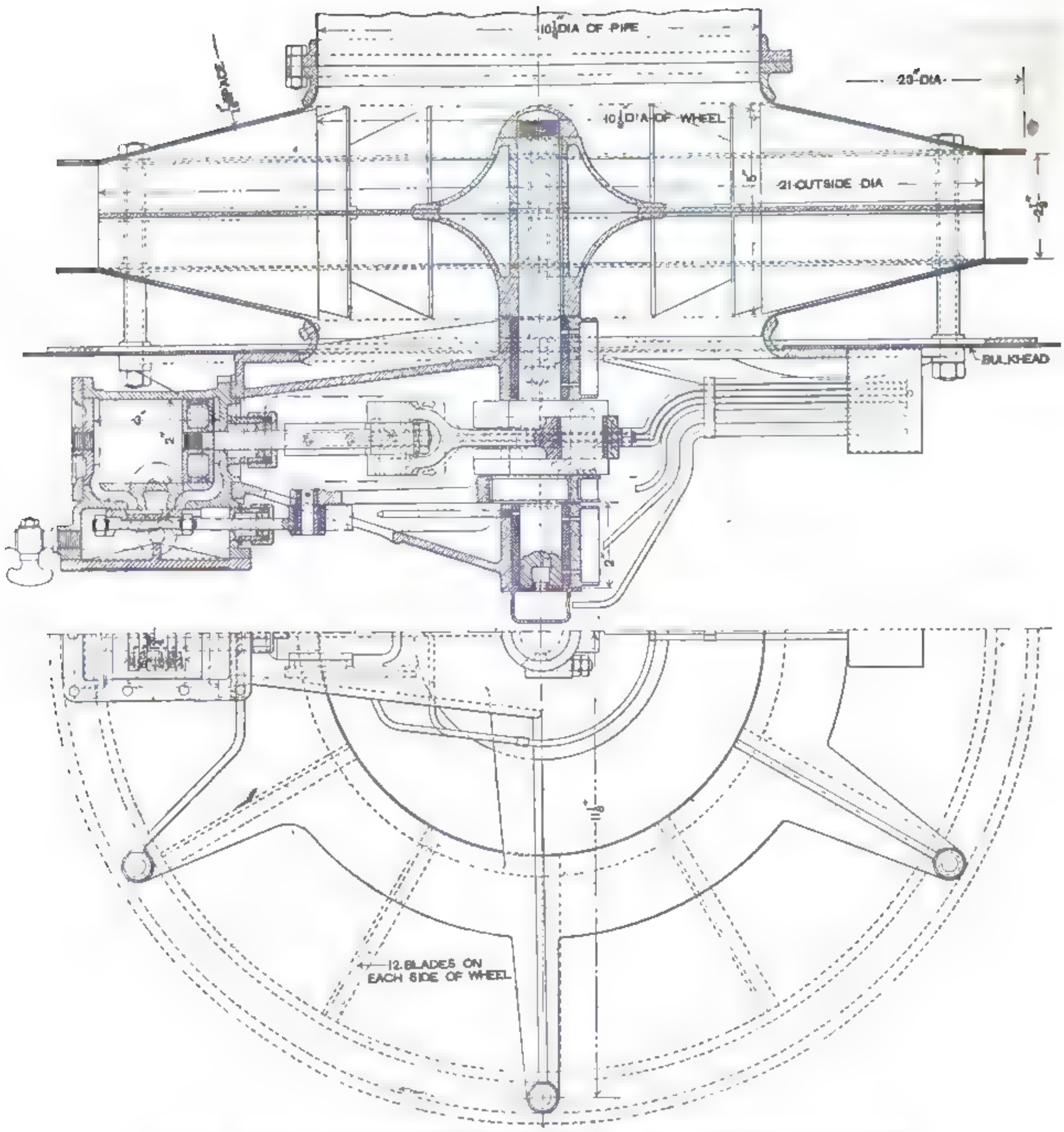
There is being built at the present time at the Brooklyn Navy Yard a third-class torpedo-boat, to be carried on the decks of the United States battle-ship *Maine*. The craft is to be about 65 ft. in length, and is to be fitted and driven by a single screw turned by the quadruple-expansion engine which we illustrate herewith. It is expected that these engines will develop about 200 I.H.P. As the boat is to be lifted from the water to the deck of the battle-ship and carried thereon, it is very essential that everything about her should be of the lightest possible construction. In a future issue we hope to be able to give a general drawing of the boat, in which it will be seen that all of the scantling is made of the lightest possible material, and this method of construction has been followed out in all of the details.

The boilers used are of the Mosher water-tube type, which were illustrated and described in our last issue. These extend clear across the vessel from one rail to the other, and there is no fore-and-aft passageway except along the deck. The engines have also been designed with a view of economizing space, and it is almost startling to note the thinness of the cylinder shells which are used on this boat. These cylinders are 6 in., 8¾ in., 11¾ in., and 15¾ in. in diameter respectively, with a uniform stroke of 8 in., while the thicknesses of their shells is ⅜ in. for the two smaller cylinders and ½ in. for the two larger.

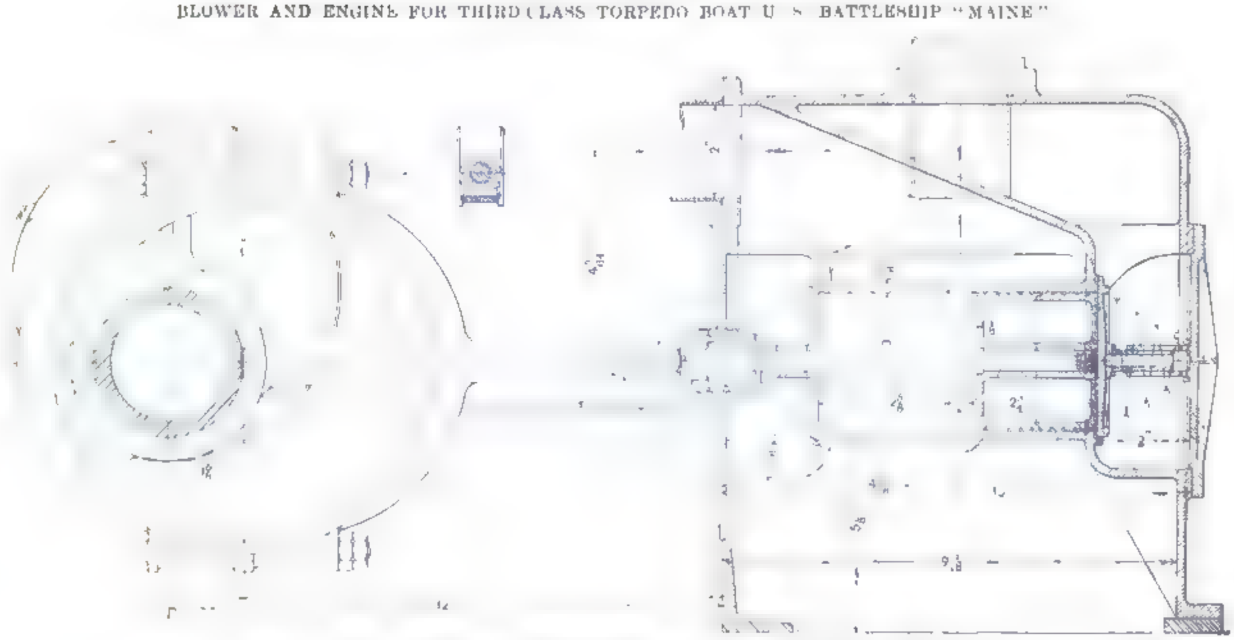
The speed at which the engine is to be run is 675 revolutions per minute. In locating the engine in the boat the high-pressure cylinder will be placed forward and just back of the boilers, allowing sufficient space for the engineer to stand and operate them. Communication is maintained between the engine and boiler-rooms through a hole cut in the bulkhead, and the space allowed for the engineer is just large enough so that he will not be cramped in his movements.

In dealing directly with the engines there is a peculiarity in the valve motions to which we wish to call particular attention. The cranks of the high-pressure and first intermediate-pressure cylinders are placed exactly opposite each other, and the cranks of the second intermediate-pressure and low-pressure cylinders are also opposite each other, but at right angles to the first, the crank-shaft being made of one piece. Piston-valves are used for all cylinders with the exception of the low-pressure. The two valves for the high-pressure and the first intermediate cylinder are operated by the same link. An examination of the drawings will show how this is very readily accomplished. Steam is admitted to the center of the high-pressure valve, and, as shown in the drawing, this is moving upward and has opened the port at the upper end of the cylinder by the amount of the lead, and at the same time the valve for the first intermediate cylinder has opened the port at the bottom of its cylinder by the amount of the lead required there. Thus, as the two pistons move down and up respectively, the valve opens the port at the top and bottom of these same cylinders. The high pressure exhausts at the end of the valve, and the first intermediate pressure takes steam at the end, exhausting out at the center and into the ends of the second intermediate-pressure valve. By this arrangement of valves compactness is obtained and the number of necessary parts reduced. As the engine is so exceedingly light, it has been very essential that all parts should be made of the best materials. The shafts and working parts generally are of forged, mild, open-hearth steel, and the piston and connecting-rods are oil-tempered. The shafts and crank-pins are hollow, the framing of the engine consists of forged steel columns stayed by diagonal braces, shown in the end elevation at the right of the engraving, in such a way as to give a firm support to the guides. The engine bed-plate is a steel plate and rests directly on keelson plates, built in the vessel, and is stiffened by an angle iron running fore and aft on each side of the engine.

We have already alluded to the extreme thinness of the cylinders, which are made of the best quality of cast iron, as hard as could be properly worked. The cylinder covers of all of the cylinders are about $\frac{5}{16}$ in. thick, but are stiffened by ½-in. ribs. Great care has also been taken that the clearance spaces should be no larger than is absolutely necessary, and the total clearance at the two ends of the cylinders has not been allowed to exceed ¼ in., which has been distributed to the best advantage. The cylinders are provided with ½-in. drain cocks, connected so as to be worked by one lever that is near the reverse lever. The pistons of the first intermediate-pressure and low-pressure cylinders are made of forged steel, dished, as shown in the engraving. The high-pressure piston is made of cast iron and weighs exactly the same as that of the first intermediate-pressure piston. The second intermediate piston is also made of cast iron and weighs the same as that of the low-pressure piston, great care having been taken that the reciprocating parts, connected with opposite cranks, should have the same weight in order to lessen the vibration. The packing rings used are $\frac{5}{16}$ in. wide and ½ in. apart, the thickness being $\frac{3}{16}$ in. for the high-pressure, ¼ in. for the first intermediate, and ⅜ in. for the second intermediate and low-



BLOWER AND ENGINE FOR THIRD-CLASS TORPEDO BOAT U. S. BATTLESHIP "MAINE."



AIR-PUMP FOR THIRD-CLASS TORPEDO BOAT U. S. BATTLESHIP "MAINE."

pressure cylinders. These rings are made of hard cast iron cut obliquely and sprung in without a follower, the joints being placed opposite. Each piston is accurately fitted to the bore of the cylinder, a play of not more than $\frac{1}{100}$ in. being allowed. The mild steel used in the manufacture of the piston-rods and other forged parts has an absolute strength of about 80,000 lbs. to the square inch, with an elongation of 20 per cent. in 2 in.

The main valves for the intermediate-pressure cylinders are packed by one cast-iron ring and follower, as shown, but the high-pressure valve is fitted accurately without rings to the bore of the valve-chamber, which is 3 in. in diameter. The cross-heads are forged with the piston-rods. Each cylinder is carried by four forged steel columns, except over the central bearings, where two columns bear the weight between the two intermediate-pressure cylinders. The bed-plate is of $\frac{1}{4}$-in. steel plate cut away for the swing of the cranks and eccentrics, and stiffened by the angle iron already referred to. The shafts are of forged steel 3 in. external diameter, with an axial hole of $2\frac{1}{4}$ in. diameter, bored through the center. The crank-shaft itself is 7 ft. 11 in. over all, and carries a coupling disk 7 in. in diameter and $\frac{7}{8}$ in. thick, forged solid to the back end of the shaft. This coupling is squared out between the bolts, so that a spanner wrench can be used in turning the engine by hand. The forward end of the shaft projects $9\frac{1}{2}$ in. beyond the forward bearing, and is enlarged at this point to a diameter of $3\frac{1}{4}$ in. for the seating of the eccentrics, from which air-pumps are driven. As will be seen from the engraving, there is a journal on each side of each crank; this is $3\frac{1}{4}$ in. in diameter by $3\frac{1}{4}$ in. long, except between the two intermediate cylinders, where there is a journal $3\frac{1}{4}$ in. in diameter and $5\frac{1}{4}$ in. long. The crank-pins have a diameter of $3\frac{1}{4}$ in. and a length of $4\frac{3}{8}$ in. for all cylinders, while the cylinder webs are $4\frac{1}{4}$ in. wide by 1 $\frac{11}{16}$ in. thick.

The propeller is made of manganese bronze, is four-bladed, 36 in. in diameter, with a pitch of 39 in., and a helicoidal area of 4.1 sq. ft. The working parts of the machinery are all fitted with lubricators of sufficient capacity to run for a reasonable length of time. Owing to the high speed at which the engine is to be run, it will be readily understood that it would be impossible to use an oiler while the engine is in motion; thus each cross-head journal take soil from an overhead cup, and each cross-head guide is oiled by pipes leading to about the middle of each forward and backing face. Each eccentric has its oil-cup so arranged that it will be oiled in all positions. An attempt has been made to see to it that, as far as possible, all the oil for the moving parts, except the main bearings, are supplied from one oil-box on the side of the cylinder with the separate valve and cocks for each part to be oiled.

The condenser is of copper No. 16 B. W. G. thick, it is $15\frac{3}{8}$ in. internal diameter and 5 ft. long: the tube sheets are made of composition metal $\frac{5}{8}$ in. thick. It contains 187 seamless-drawn brass tubes $\frac{5}{8}$ in. outside diameter, giving a cooling surface of about 150 sq. ft., measured on the outside of the tubes. The longitudinal seams are brazed. The air-pumps consist of two double-acting horizontal pumps, worked from eccentrics on the forward end of the main shaft. Each cylinder is 3 in. in diameter and has a stroke of $3\frac{1}{4}$ in. Both the cylinders and casings are in one casting. The suction nozzle is at the inboard end of the casing above the cylinders and opens into a suction-chamber formed around the cylinder. In the center of the cylinder there is a slot $\frac{1}{4}$ in. wide extending entirely around the cylinder and connecting it directly with the suction-chamber. The thickness of the piston is such that it will just give a full port opening at each stroke, so that there are no suction-valves, the piston itself taking the place of one. The piston is hollow and is filled with water-excluding material. The external surface is fitted with grooves for water-packing, and is of such a length that it comes about flush with the cylinder end at each stroke. There is a delivery valve for the end of each cylinder. They are flat on the face, and there is no more than $\frac{1}{16}$ in. clearance between them and the end of the piston when the latter is at the end of its stroke; the inboard valve is guided on the piston-rod, while the outboard is guided by a pin on the cylinder bonnet, as shown; the valves are kept on their seats by conical springs of phosphor bronze, which are set to produce a pressure of about 7 lbs. The guides for the connection between the eccentrics and the piston-rods are cast on the inboard bonnet. The eccentrics that do the driving have a diameter of $7\frac{1}{4}$ in. and a wearing face of 1 in.

When the plans for this vessel were in preparation, estimates and bids were asked from blower manufacturers for ventilators and blower fans. While many of them could guarantee to fill the requirements for delivery and pressure, the weight they required was so far beyond that which could be allowed, that the department designed the blower which is shown in our engraving. It is driven by a single engine, with a cylinder 2 in. in diameter and a stroke of 2 in. The piston is $\frac{3}{4}$ in. wide, is hollow, is packed by water-rings, and is screwed upon the piston-rod. The valve is a flat D-valve driven by an eccentric. The fan consists of a disk of composition metal, 21 in. outside diameter, and No. 18 B. W. G. On either side of this, blades are attached of the size and shape shown by our engraving. There are 12 of these on each side of the wheel, and they run in a copper casing 28 in. outside diameter. The suction-pipe leading to the fan is $10\frac{1}{4}$ in. in diameter.

This engine and fan has not yet been placed in the vessel, which is incomplete, but shop tests have been made of it at a speed of 2,000 revolutions per minute. Under these conditions it has a delivery of 6,000 cub. ft. of air per minute under a pressure of 3 in. of water.

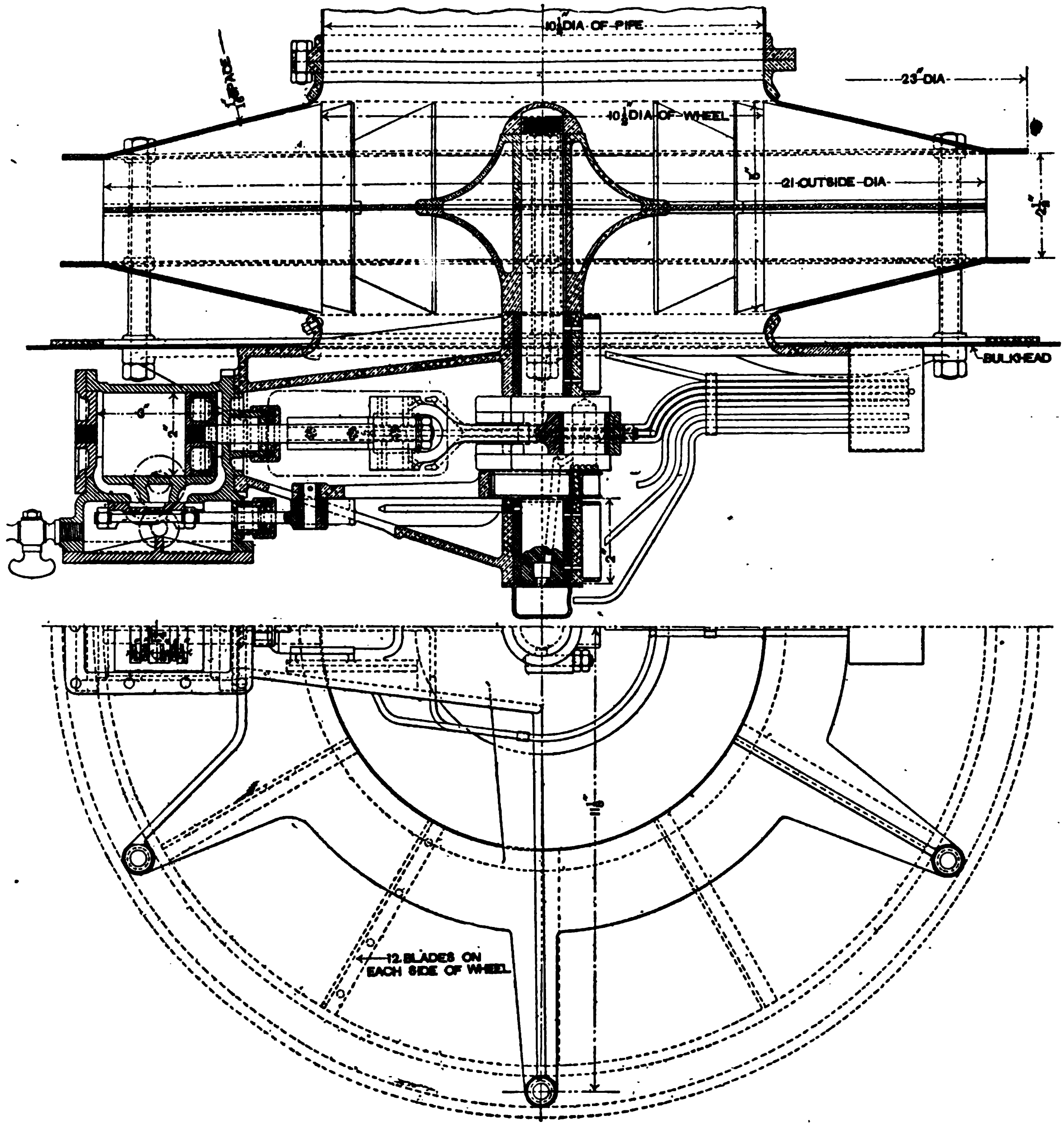
Whether such a vessel as this would show great qualities as a fighter remains to be seen, but the designing of such engines cannot fail to have its influence in showing what can be done to those who are striving to obtain light motors for other purposes than that of marine and stationary work.

BROWN'S HIGH-SPEED ENGINE.

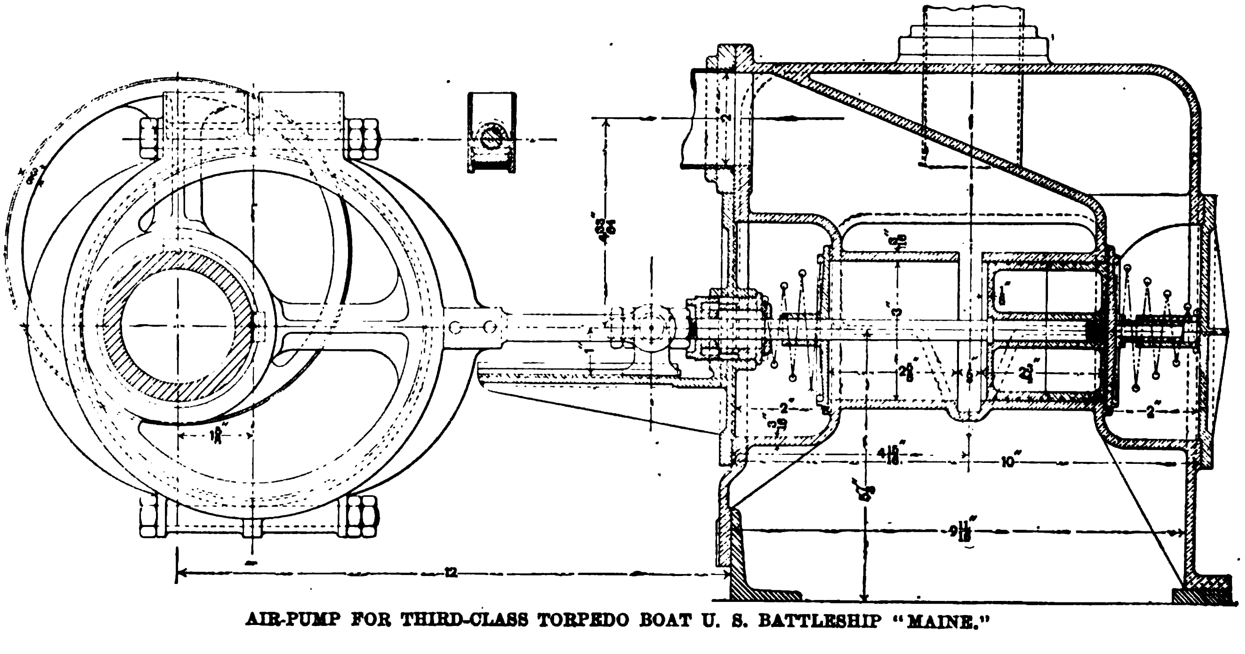
Mr. Charles Brown, who was formerly connected with the Winterthur Works, at Basle, Switzerland, has been paying considerable attention of late to the development of electrical apparatus. In another column of this paper will be found a description of an electric car that he has recently patented, while in this connection we illustrate a high-speed engine which he has designed. This engine is of the high-speed type, being intended to be coupled directly to the armature of the dynamo and to run at the speed of 600 revolutions per minute. The diameter of the cylinder is 5.5 in., and the stroke of each piston is 3.9 in. The drawing from which our engraving is made bears the statement that the effective pressure used is 10 atmospheres, or 150 lbs. per square inch, and that the engine is rated at 16 H.P.

As there is a mark of originality on everything emanating from Mr. Brown, we would naturally expect something out of the ordinary run when he sends a new high-speed engine out into the world, and we are not disappointed. At the very outset we are met with a novelty in the cylinder, which contains two pistons running in opposite directions, and attached to cranks set at 180°. By making the total weight of all reciprocating parts of the two cylinders the same a perfect balancing is obtained. The rod of the lower piston is hollow, and is screwed into its cross-head, upon which there are two wrist pins, and from these there are two connecting-rods leading to the two cranks located on either side of the single crank of the upper piston. The upper piston has a solid rod, grooved for water-packing, which passes through the hollow rod and is made solid with its own cross-head. Even the connecting-rods are different from the ordinary. The single rod of the upper piston spreads out into a Y at its upper end, and takes hold of the two wrist-pins of the cross-head. At the lower end there is a shoe held between the two arms of the rod by a bolt. This shoe has a composition metal bearing on the underside of the crank-pin and is stationary, the adjustment for wear being made by the screw and brass foot shown above the pin.

The engine is single-acting, after the manner of the Westinghouse engine, with the difference that here the pressure is exerted upon both pistons at the same time, and, as steam is admitted to the cylinder at the center, the strain on one piston is upward, while there is a downward thrust upon its mate. If there was a novelty in the cylinders, there is a still greater in the steam distribution and valve arrangement. Steam enters at A, passes through the throttle-valve B, through C and D to the belt E, extending entirely around the cylinder and having openings shown by the dotted lines up to the valve face below F. The valve is an annular casting with a series of stalls N (see fig. 4) leading in from the inner passageway F. At the upper side the valve carries the teeth of a spur-gear, K, that mesh in with those of the pinion J, which is keyed to a vertical valve-rod. This valve-rod is given a continuous rotary motion by means of a worm I on the main shaft, that drives a wheel on the vertical valve-rod already alluded to. This motion is necessarily very much slower than that of the engine, and even this speed is still further reduced by the ratio existing between the gear K and the pinion J. The speed of the valve is such that the stalls N come into line with and open the ports G in the valve-seat at the proper time for the admission of the steam between the pistons. The valve, rotating in



BLOWER AND ENGINE FOR THIRD-CLASS TORPEDO BOAT U. S. BATTLESHIP "MAINE."



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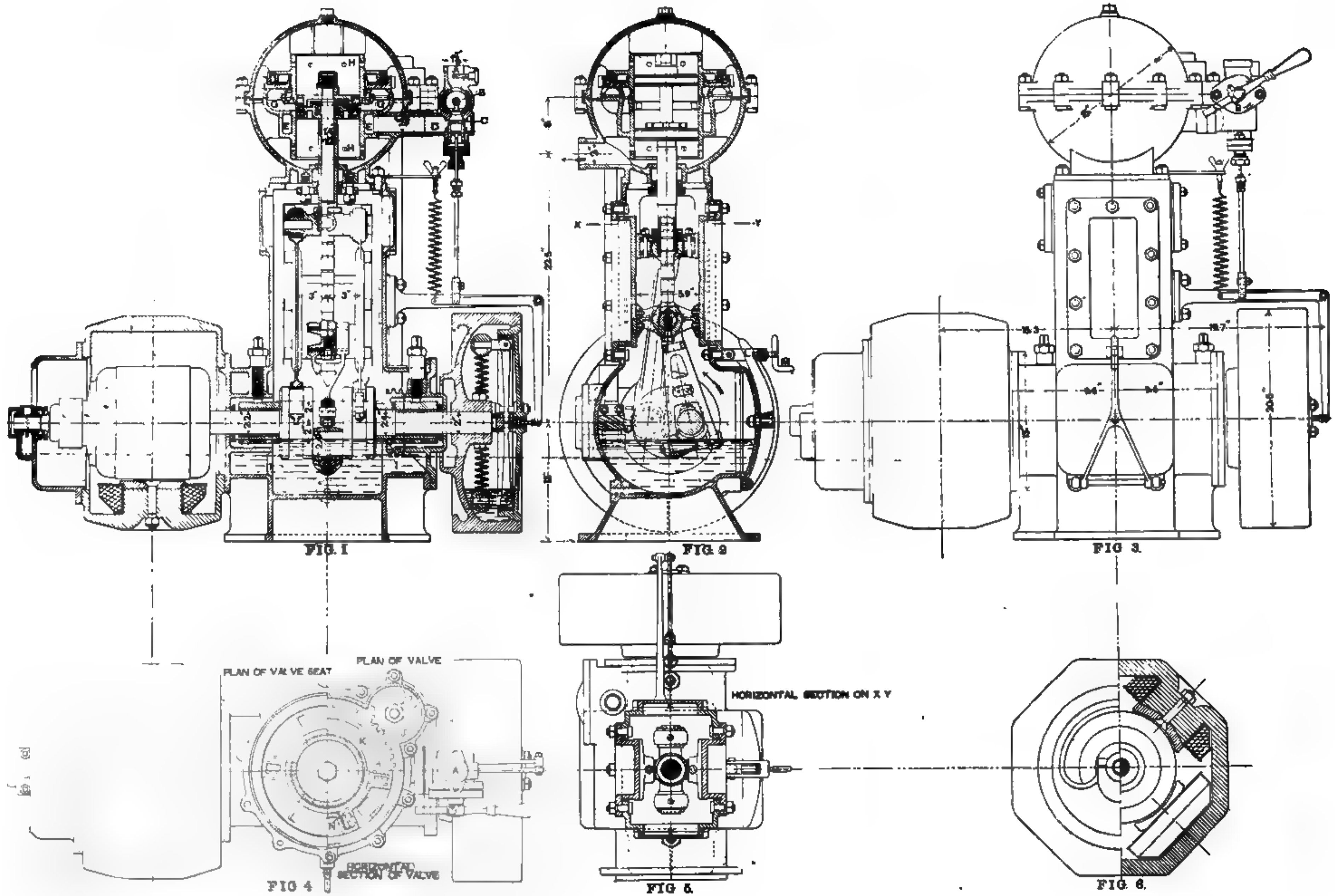


HIGH-SPEED ENGINE, DESIGNED BY MR. CHARLES BROWN, BASLE, SWITZERLAND.

one direction, is an admission valve only. The exhaust is obtained by giving the pistons such a stroke that at the extreme outer ends the ports *H H* at the upper and lower ends of the cylinder are uncovered, allowing the steam to exhaust into the chamber formed by the spherical casing, from which it escapes to the atmosphere or condenser through the 2-in. pipe at the left of fig. 2, as indicated by the arrow.

The regulation of the speed is obtained by means of a throttling governor, the construction of whose valve *O* and other details is very clearly shown by fig. 1. The fly-wheel carries a pair of bell-cranks, on the short arms of which are the weights. As they move outward under the influence of centrifugal force the long arms are drawn in, acting, in turn, upon the exterior bell-crank in a manner that is very readily traced through to the valve by reference to the engraving.

The similarity to the Westinghouse engine once more appears in the dipping of the cranks into the oil-well at the bottom of the frame at every revolution. The cellar is closed by a tight door shown at the right of fig. 2. This door is kept to place by the hinged lever *L*, against which a screw is forced by the small crank *M*. The fly-wheel also carries oil in the bottom of its interior, as shown, by which the moving parts of the governor are thoroughly lubricated.

One feature of the engine will commend itself to all mechanics, and that is the accessibility of all parts for easy inspection and repairs. The governor is open to inspection and adjustment at all times; by draining the oil cellar the door can be opened by a few turns of the handle *M*, and the bearings of the cross-head reached. The cross-heads are free at all times, and the valve is accessible after the removal of the hemispherical casing. We have as yet received no record of the work done by the engine. As for repairs, it would seem that the principal point to be looked to in order to keep these down would be the securing of a proper lubrication for the valve.

CENTRIFUGAL PUMPS.*

By John Richards.

(*Continued from page* 418.)

II.—History of Centrifugal Pumps.

I presume each prominent nation in Europe considers the invention of centrifugal pumps as belonging to their people, and it was a matter of no concern until the method came to be applied to useful purposes, and took its place as a manufacture, but there is scarcely a doubt that the first organized centrifugal pump was invented by Denis Papin, about 200 years ago, in Hesse, Germany, where it was called the "Hessian suck." This pump of the celebrated Frenchman, of which there are drawings in existence, was by no means a bad one, and in all essential features, except a volute casing, corresponded to the construction afterward adopted in this country in 1818.

The celebrated Dutch engineer Huet says that Perreboom introduced the horizontal centrifugal pumps in Holland in the first years of the nineteenth century; but as no precise date or examples are named, some allowance can be made for Huet's evident prejudice against centrifugal pumping, because he instantly follows this remark with the statement that 30 years later Lipkens made his celebrated single-acting pump for draining Haarlem Lake. Huet's work, "Stoombemaling Van Polders and en Boczems," 1885, gives scant mention of centrifugal pumping, although at that time such pumps might be said to have supplanted to a great extent the old cumbrous Dutch pumps in Holland, as elsewhere.

Another of the oldest drawings, extant at this time, is that of Le Demours, a Frenchman, dating from 1732. It is a kind of "Barker mill" machine, and the forerunner of various other pumps on the same principle, that of Barker's mill inverted, which have been periodically invented ever since—one within the writer's knowledge a few years ago here in California. The same invention, or "mode of operating," is said to have been discovered in connection with reaction water wheels by their overrunning and drawing the water from the chute or inlet after the gates were shut.

Mr. Whitelaw, an inventor of reaction water wheels in their common or applied form, himself converted the method to pumping by centrifugal force, and made pumps of the submerged type that gave some very good results, which were fortunately tabulated in a careful manner in 1849, at Johnstone, near Glasgow. These tables contained factors for friction of both water and machinery, with exact measure of resistance and power, that would do credit to a scientific commission of our day. The tables will be given in another place. Whitelaw's pumps were first made about the year 1848.

To begin at the true beginning, when centrifugal pumps first took practical and useful form, we have to, as before claimed, come to the United States.

It is a commonly entertained opinion in this country that centrifugal pumps were invented and first applied in Europe, and the art, to so call it, is one in which American engineers and mechanics had but little part down to recent years. This opinion being, inferentially at least, promulgated by some recent articles on the subject (1886), has prompted the writer to carry out a long-intended purpose of giving some history of this important manufacture, and establish, as far as ascertainable facts will serve, the part that has been contributed from the United States.

It will, no doubt, be a matter of surprise to most of our readers to know that centrifugal pumps as practical operative machines are strictly and entirely an *American invention*, and that 20 years before such pumps were made or known in Europe they had in this country attained a form and efficiency but little inferior to the best practice of the present day, and in some respects superior to pumps that are now made and sold. This matter will, in a future place, be explained, and drawings given of American centrifugal pumps made between 1818 and 1830, long before any such manufacture was thought of in England, or on the continent of Europe.

THE MASSACHUSETTS PUMP.

A pump embodying almost every essential feature of modern practice was invented in Massachusetts in 1818, 30 years before the same thing was applied in Europe, and 40 years before there was a modification there that can be called an improvement.

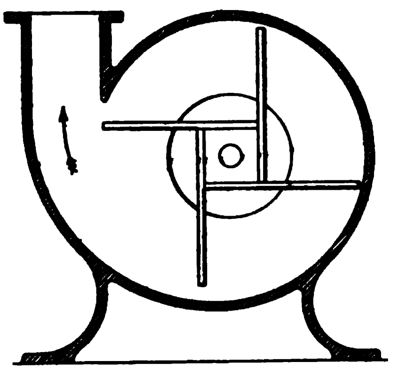


Fig. 13.

THE MASSACHUSETTS PUMP.

The drawing (fig. 13) is a section through what was called the Massachusetts pump of 1818. It, as can be seen at a glance, is the "parent of its tribe," the completed machine, and in useful effect would equal, if not excel, either of the modifications exhibited at London in 1851, 33 years later. It is proposed, however, in the present chapter to deal with the chronological part of the subject, and discuss separately the merits and constructive features of the different pumps.

The Massachusetts pump fell on barren ground. There was at the time but little use in the United States for such pumps, and but scant means of communicating inventions over the country. There was land enough without draining it, and water-raising except from wells was exceptionally required. We, however, hear of the Massachusetts pump finding its way to New York in 1830, and being exhibited there with very satisfactory working results, guessed at then no doubt, but ascertainable even now if it were worth the trouble.

The casing was of rectangular section, beveled from the center to the periphery, but not in a degree to conform to volume and velocity, as a theoretical pump of our day would be, but an approximation that showed the inventor had an inception of the true working conditions.

The first pumps were made to operate under water, like those of Bessemer; and I conjecture the improvements mentioned in connection with the exhibition at New York in 1830 to be the addition of side suction pipes, because the pumps were exhibited in public, which could not well have been done if they were submerged.

GWYNNE'S CENTRIFUGAL PUMPS.

The Gwynne pumps, referred to in the writings before named, are of American origin. They were at first an attempted and doubtful improvement on American methods well known and successfully applied at the time; not only this, the first experiments of Mr. J. S. Gwynne, the senior brother among those of the name now comprising the firm of Gwynne & Co., and J. & H. Gwynne, of London, England, were made in Pittsburgh, Pa., in 1844. The first pump made by Mr. Gwynne was for the Passaic copper mine, in New Jersey, the location of which I am unable to ascertain at this time.

Mr. Gwynne's first patent was taken out in the United States, from New York, where he then resided, and where he continued to reside for some years after the great contest and controversy with Appold at the London Exhibition of 1851, when such pumps were for the first time publicly exhibited in Europe.

The pumps shown there by Mr. Gwynne were called "Gwynne's American Pumps," and it was, no doubt, in some measure, due to this fact that the controversy arose between he, Easton & Amos—now Easton & Anderson, who exhibited the Appold pumps—also with the makers of what is called the Bessemer pump, as will be hereafter explained.

I think the term "Gwynne's American Pump" was hardly correct, because Mr. Gwynne's alleged improvements on the American pumps, as before intimated, were of questionable value, as he would no doubt now admit; at least they form no part of his present practice, and, as a matter that need not be one of opinion wholly, I will venture to claim that had the centrifugal pumps as made in America previous to Mr. Gwynne's improvements been put in competition at the exhibition of 1851 they would have given much better results than either of the three that were exhibited there.

The drawings to be given hereafter will prove this, because, in the light of modern experience, the duty of a pump of this kind can be very fairly ascertained from its construction.

The experience of Mr. Gwynne in the United States during a term of 10 years or more was, in a sense, the foundation of the manufacture that bears his and his brother's names. This manufacture, which is one of the greatest facts in the recent history of centrifugal pumps, was but a continuance of the art transplanted from America, and for a long time without substantial improvement except in workmanship and strength. It will not be too much to claim that after various experiments and modifications the practice *settled down to very nearly what it was in this country in* 1830. It went through a cycle of change and experiment, which, as will be shown in a future place, was alike unusual and not flattering to engineering skill of 40 years ago—not to be wondered at in this case, however, because the construction of these pumps has even now scarcely settled down into a regular engineering manufacture.

The comparatively limited use for pumps of the kind in the United States, where no lands were drained, where water-raising was seldom performed under circumstances requiring centrifugal pumps, permitted this manufacture to lag behind. It also fell into the hands of firms without engineering skill, or without the skill and opportunities required to develop it as the firms of Gwynne & Co., and John and Henry Gwynne, have done in England since 1855.

The works of Gwynne & Co. were situated at the water side, just south of the Temple in London. The ground on which these works stood was acquired by the Commissioners for the Victoria Embankment, and the works were moved back to a position almost opposite the Temple Station of the Metropolitan & District Railway.

The works of John and Henry Gwynne are at Hammersmith, 8 or 10 miles westward on the Thames, and among the engineering manufactures of England it is to be questioned whether, on the grounds of careful workmanship, the selection of material, or general good quality, there is any branch more carefully conducted.

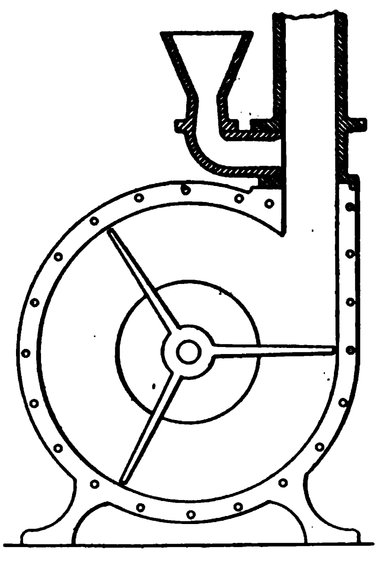


Fig. 14.

EARLY GWYNNE PUMP.

The pumps, as before claimed, have gone through a maze of modification both in England and on the Continent. There has been retrogression as well as advance, and, except in the case of Messrs. Gwynne and some other firms that follow them, there is not much beyond the American practice of 50 years ago.

Mr. Gwynne, in his patent of 1851 in the United States, begins his claims by saying, "I do not claim to be the inventor of centrifugal pumps," and after other negation to qualify his discoveries, confines his positive claims to certain mechanical details, which, as before remarked, have long ago disappeared in his own practice, and, so far as I know, never had place in any machines except those made soon after 1850. The pump for the Passaic copper mine was, we may infer, in its main features, similar in construction to those exhibited in London in 1851.

This latter was an encased impeller pump with an arrangement to protect the back of the disk from pressure, there being a single inlet at one side. It was carefully engraved at the time, and can be examined in the patent and other references now available. It was called "Gwynne's Direct-Acting, Balanced-Pressure Centrifugal Pump," and called also, as before mentioned, "Gwynne's American Pump." It is shown in fig. 14.

BESSEMER CENTRIFUGAL PUMP.

Messrs. Gwynne, Appold, and Bessemer were exhibitors of rival pumps at the exhibition of 1851, and out of a controversy that arose there we are indebted for some history of American pumps that would otherwise no doubt be lost. Our meager records of that time, and a period of no record of inventions to speak of, from 1818–47, has left us without history of early practice in this country, but in order to combat some of the claims made by Mr. Bessemer (now Sir Henry) Mr. Gwynne and his friends were obliged to bring forward accounts and descriptions of the American pumps that formed the basis of Mr. Gwynne's practice. This, however unwillingly it were done, was unavoidable, because Mr. Bessemer had attached to his pump at the exhibition a placard bearing the following inscription:

"This model of a centrifugal pump for forcing fluids is made in rigid accordance with the specification of Mr. Bessemer's patent, dated December 5, 1845, being the first recorded invention for impelling fluids by centrifugal force by a revolving disk."

This pretentious claim will appear a little ridiculous in the light of the facts, unless the word "recorded" is employed as a qualification; at any rate, it gave offense to Messrs. Gwynne and Appold, and, as before remarked, caused a controversy between the commissioners and jurors of the exhibition as well as exhibitors.

No doubt Mr. Bessemer had made an original invention so far as he was concerned, and discovered the employment of centrifugal force for "impelling fluids." He was, in fact, engaged in making centrifugal drying machines for sugar, and, no doubt, at the time had more to do with centrifugal apparatus as an element in machine construction than any engineer then living. His pumps as then made, subsequently improved and patented again in 1849, bear in many respects close analogy to centrifugal drying machines. One idea was born of the other, or, as might be said, one idea is almost the same as the other, and it would be quite unfair at this time to detract from the importance of Bessemer's invention, however much we may differ from the particular methods of application and use.

The adaptations shown in his elaborate patent of 1849 exhibit a fertility of experience and acquaintance with constructive mechanics that remains remarkable even to this time.

The controversy mentioned culminated in a challenge from Mr. Gwynne to operate the pumps in competition for a year, the losing competitor to pay £1000 into the treasury of the London Mechanics' Institution. This challenge was not accepted.

REPORT OF THE UNITED STATES COMMISSION AT VIENNA.

A claim to original discovery of particular inventions on national grounds is in many cases silly and provincial, but in the present is so marked and has been so ignored that its review will be a matter of common fairness, especially as common opinion in the matter is to some extent based on the report of the American Expert Commission sent to the Vienna Exposition in 1873. To this report is due, unfortunately, in a great measure the idea of centrifugal pumps being of European origin. This report is a remarkable one, not only in a distortion of facts, but in the ignorance of hydrodynamics which it presents.

Without wasting space to quote further from this report, the following salient points appear (see pages 193 *et seq.*):

"(1) Appold was the introducer of this class of pumps; (2) they are misnamed centrifugal, because they do not operate by centrifugal force at all; (3) they operate by pressure the same as a turbine water wheel; (4) when people understand their method of operating we may expect much improvement; (5) they should have disk runners, because the fan wheels will soon wear out."

This much, I think, will do. This extraordinary report stands printed in a Government publication, signed by men who were, or are, eminent in mechanics, and we can only deplore the stupidity as well as presumptiou of the commission who thus disposed of a subject that had twenty years before been carefully investigated by such men as Sir John Rennie, Professor Cowper, Mr. Whitelaw, Dr. James Black, Professor Rankine, and many others. The most astonishing part is, however, that this report was passed and signed by men who we can hardly suppose would fail to perceive its absurdity.

BLAKE'S PUMP.

Returning again to American pumps, in 1831 Messrs. Blake, of the New Steam Mills, in Connecticut, invented one, shown in fig. 15, and well worthy of attention here as being the first of its type, and almost identical with Bessemer's of 1845 and 1849. It is, in fact, the better machine if carefully compared, but subject, like nearly all disk pumps, to lateral thrust upon the impeller that would cause difficulty in working.

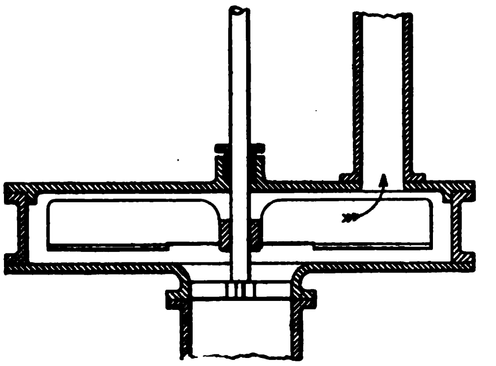


Fig. 15.

It was in every sense a "departure," and is by no means obsolete at this day for high lifts. The force of the issuing water, or its tangential energy, is lost, as may be seen by the annular casing and change of the water's course, but this loss has to be measured by the relative speed between the wheel and off-flowing water, as has been explained. This invention has of right a prominent place in the history of centrifugal pumps.

ANDREWS' PUMP.

The next American pump to follow was that of Andrews, invented or published in 1839, the first American pump with a cylindrical discharge chamber. If the Massachusetts pump came near anticipating our best modern practice, the Andrews pump completed the matter, and leaves room for the lament of Lord Byron that "those thieving ancients have stolen all of our modern ideas."

The construction, in side view, is identical with the Massachusetts pump invented in 1818, and shown in fig. 18, the difference not demanding a new drawing, Andrews' invention relating to a cylindrical chamber at the vane tips. Excepting the straight vanes and one or two less important points, the pump is capable of high duty, and conforms very nearly to good modern practice for dredging purposes.

The effect of curved vanes, as has been explained, is dependent on speed or pressure, and is not a qualifying factor of the pump's duty unless pressure be included, and it is safe to claim that for low heads this American pump of 1839, made long before any such machine was known in Europe, is capable of a duty within 10 per cent. of the best modern performance, and its only distinguishing feature, comparing with its predecessor, the Massachusetts pump of 1830, is a casing of cylindrical section not differing at all from the patterns in use at the present time by several makers in the Eastern States.

The transverse section of the pump would show the "waterway" diminished from the inlet to the periphery to conform as nearly as practicable to volume and velocity; in fact it was in this respect much better proportioned than many pumps now being made and sold. This pump, let it be remembered, was produced and publicly known five years before Mr. Gwynne's experiments at Pittsburg, and at a time and place that leaves only the Massachusetts pump as a possible precedent.

We must not, however, detract from the last-named pump further than to call Andrews' an improvement. It is a step further in the art, and a very possible invention that any one might make, and, no doubt, a result of improvement in mechanical facilities for making the casing of two pieces of cast iron, and the water duct of cylindrical section.

WHITELAW'S PUMP.

This brings us down to the time of Whitelaw's experiments at Johnstone, near Glasgow, in Scotland. The exact time is not known, but it was between 1847 and 1849. Mr. Whitelaw was the inventor of a water wheel that bears his name, and his pumps, which he describes as "especially suited for draining lands," are in most respects an "inversion" of his water wheels.

Fig. 16 will give an idea of the arrangement, which differs but little from pumps erected within a few years past by thorough engineering firms in England, and also of some made from the writer's designs now in use in California.

The most remarkable feature of Mr. Whitelaw's experiments is the very complete knowledge of hydrodynamics they show. The following are four out of nine columns in tables he prepared from experiments to determine the efficiency attained by his pumps:

No. of Experiments.	Revolutions of the Pump.	Loss by Friction and other Resistance in the Pump.	Loss by Force of Water after Leaving the Pump.	Efficiency. Power of Pump Motor being 100.
1	337.6	19.370	7.314	69.23
2	278.4	12.780	9.462	73.18
3	226.8	7.087	13.980	79.67
4	199.0	4.466	18.620	75.78
5	182.0	2.984	23.780	76 48

The power was measured by a dynamometer of delicate construction, and the experiments in every way conclusive. The formulæ employed in his computations can be found in the *Practical Mechanics' Magazine* of 1850.

There is an erroneous opinion existing respecting the efficiency of pumps of this kind, of which more will be said hereafter; at present I will, however, point out that the effect produced by Mr. Whitelaw with his submerged wheel was 7 per cent. better than anything attained in the exhibition of 1867, and might have been much more if the up-take had been an annulus—that is, the main casing filled in, so the discharge energy would not have been lost in the large body of nearly still water above the wheel.

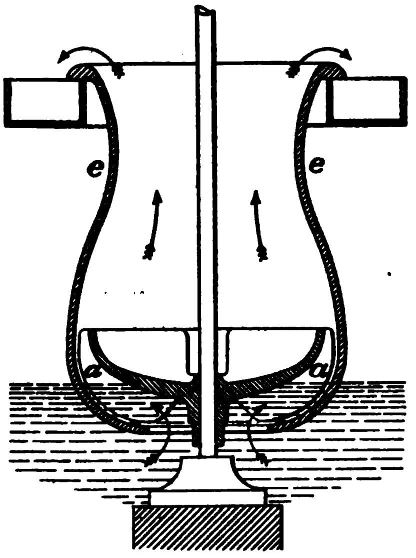


Fig. 16.

The next stage in centrifugal-pump history includes the experiments of Messrs. Gwynne, Appold and Bessemer, of which some account has already been given.

The pumps produced by Gwynne we can presume to be the same, or analogous to, the one patented in 1850, and shown in fig. 14. This pump affords room for extended comment, which must, however, be passed over here. It was the one shown in competition with the Bessemer and Appold pumps at the exhibition, and by no means so good a one as its predecessors in America, although more expensive and complicated. In support of this opinion I have only to refer to Messrs. Gwynnes' modern practice. The discharge chamber was annular, as shown in the side view.

BESSEMER'S CENTRIFUGAL PUMP.

In 1845 Henry Bessemer, now Sir Henry, invented and patented his centrifugal machine or pump, before referred to.

It is not necessary to give drawings of this machine. It had simply an encased impeller, or "runner," as we now say in this country, revolving in a free chamber or casing, the discharge or tangential force of the water being neutralized and lost in the surrounding body or stratum. The writer has rea-

son to understand these pumps, having himself gone through perhaps the same chain of experiments and reasoning 40 years later, but with a different result. The principle or method of operating was found applicable to high heads or high pressure, the loss of power being to a great extent compensated in other ways.

The pumps of Mr. Bessemer constituted a kind of "roundabout" way of attaining a simple result, and contained some kind of a pneumatic attachment that we need not now trouble ourselves to even inquire about, and much less to describe. The pump, aside from its last-named feature, which was no essential part of it, had been not only anticipated, but exceeded by Blake's of 1831, shown in fig. 15, which was a better and more simple machine, embodying all the operating features of its pretentious successor of 14 years later.

I am not at all astonished at Mr. Gwynne's resentment respecting the Bessemer pump, or the Appold pump of Easton & Anderson. Both of them were, in a sense, "upstarts," as their subsequent history has proved. We must, however, concede to Mr. Bessemer, and no doubt to Easton & Anderson also, that they were not aware of what had been done in this country more than 30 years before.

In 1846, after the Andrews pump had been applied to a great variety of purposes in this country, it was improved and again patented both here and in England, Messrs. Gwynne & Co. acquiring the right for that country.

At this date we find the encased or closed impeller so nearly conforming to the present form that its invention may with all fairness be ascribed to Mr. Andrews, and claimed for this country. This has been conceded by impartial English authority of 6 years later, and adds another to the claims that can be made in respect to the origin of centrifugal pumps in the United States.

In the same year (1846) Messrs. Von Schmidt, of New York, patented in this country a new modification of centrifugal pumps, an adaptation or change of the Andrews pump, but having no claims beyond its early date that need receive attention here. A glance at the drawings of the Von Schmidt pump will show that the theory of their action was not very well understood.

THE APPOLD PUMP.

In 1848, 2 years later, we come to the celebrated Appold pump, and the first comment must be that there was no reason for celebrity in the case. The Appold pumps were made by Messrs. Easton & Amos, now Easton & Anderson, of London, then and now very celebrated hydraulic engineers; but in so far as Appold's pump the only new feature was the curved blades conforming to the Barker mill pumps that had preceded. Appold's first pumps had diagonal vanes set at an angle of 45° from a diametrical line, afterward altered to those curved backward. The want of novelty in this is sufficiently proved by the fact that no patent could be procured on this alleged invention.

In some cases for low heads, where a pump's work is performed by impact, or "mechanical push," it may be called, more than by centrifugal force, curved vanes of the Appold form would not only have no useful effect, but cause a lower efficiency.

The change of Appold's wheel or disk from a tapered section, with a discharge orifice of narrow width, to one with parallel-sides, shows that at least one of the main laws of hydraulics, a change of velocity without change of volume, was not known or else was disregarded. Even recently, however, one mathematical authority has assumed that the converging wheels were of no importance, ignoring the friction of the broad vane tips, overrunning the water as six to one at a head of 40 ft.

On the whole we are justified at this distance of time, when the merits of various methods have been demonstrated by experience, in concluding, as before intimated, that the reputation of the makers and the contest at the London Exhibition of 1851 did more to make the Appold pump known than its working merits.

Subsequent tests, notably one at the Chatham Dockyard, in England, and one at Trafalgar Square, London, showed that however important the curved vanes might be, other features of the pump were bad or wanting. Messrs. Easton & Anderson have, however, constructed some of the best and most efficient centrifugal plants known.

The fact is that the controversy of 1851, so often mentioned here, removed the pump matter from the field of engineering investigation to one of commercial contention. In respect to vanes, for example, there were at the time in England plenty of engineers and scientific men who could have developed from mathematical data the true and best form for pump vanes at different heads.

It is true Professor Rankine defined a form of vanes which did not give a good result under certain circumstances. I am speaking from memory, not having seen the drawings for some years past, but, as now remembered, Rankine's proposed vanes were suited for low heads only, and, no doubt, his computations were correct, as all must be if the premises are not mistaken; I may also remark, in respect to Appold's wheels, that computation would not in any case have produced vanes of a true curve such as are shown in drawings of his pumps made at the time.

Bessemer's second patent of 1849, a treatise it might be called on the general and special adaptations of Mr. Bessemer's pumps to various purposes, is an interesting study at this day. His pumps, as before remarked, can be explained by referring to Blake's pump, fig. 15, which is typical of all the modifications in Bessemer's patent of 1849, and already sufficiently discussed. Then followed Gwynne's improved pumps, and to Messrs. Gwynnes' credit be it said, the workmanship on centrifugal pumps and the engines to operate them reached in the hands of this firm a perfection that perhaps no other branch of similar engineering work could at the time excel. The efficiency attained with centrifugal pumps was, by this time, such that Harvey's compound direct engines, employed to drain Haarlem Lake in Holland, could have been excelled in performance at one-half the original cost had centrifugal pumps been employed for the same work.

It has been extremely difficult to ascertain the dates heretofore given. They reach back but 76 years, but have been found in fragments, and are far from orderly arrangement here.

THE PROGRESS OF THE "ART."

It is, perhaps, in all cases unfair to indulge in censorious opinion respecting the past history and rise of an engineering manufacture, or the development of a new class of machinery, but if there ever was a case where such opinion was justifiable, that of centrifugal-pump progress is such a case.

For more than half a century the pumps remained practically where they began. "The last was like unto the first," and during this period there was mistake, retrogression and a failure to discern simple elementary principles that surpasses present belief.

To prove this, one has only to compare the first American pumps of 1818 with those now made in this country, and by Gwynne, Allen, Drysdale and others in Europe at the present day. This is enough to show how little has been changed or improved, but it fails to in any degree indicate the practice that has intervened.

The dynamical laws or principles involved in the operation of centrifugal pumping seem to present but little of the complicity attendant on heat engines, or in dealing with expansive gases. The problem is simple in comparison with the mathematics of projectiles, of turbine water wheels, or a dozen other things that might be mentioned, that have arisen and been disposed of during the time.

Centrifugal pumps have gone through a development of experiment by mechanical expedients, a method generally slow and uncertain, not wholly so, however, because in 1848 we find Mr. Whitelaw making computations involving all the principal conditions of centrifugal pumping. Still further on, however, we find the celebrated Mr. Rankine suggesting curves for the vanes of such pumps, at variance with the almost universal Appold form.

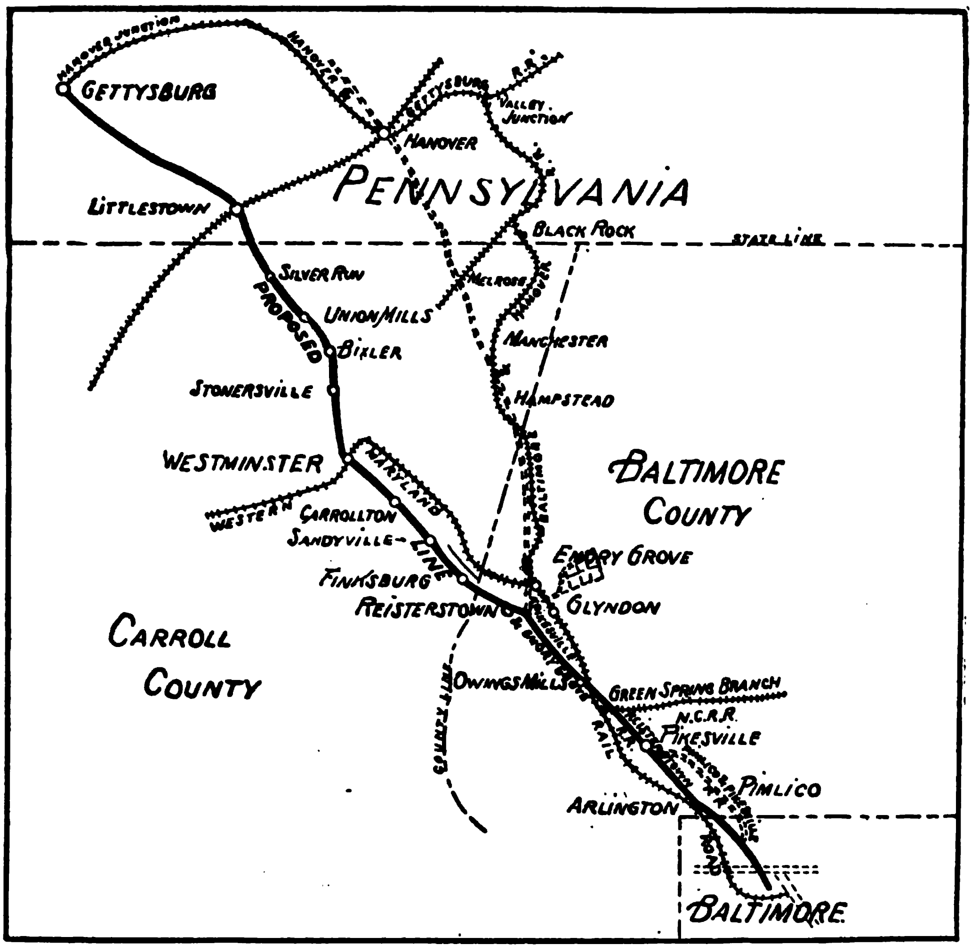
Encased impellers have been one of the stumbling-blocks over which nearly all pump-makers have made their way. Blake, Gwynne and Andrews in America, and Bessemer in England, have all contributed to this error, if error it be, and within a few years past the same old round has been gone over again by a firm in Massachusetts that adopted the Gwynne pump in other respects, but at first employed a Bessemer or Andrews impeller. In a recent number of the *Engineer*, London, appears in an advertisement various sizes and adaptations of centrifugal pumps, all constructed with encased impellers. The writer and some other makers in California followed the same course, and, as before remarked, this thing has been taken up and at some time abandoned by nearly all prominent makers of centrifugal pumps.

The causes for this are not difficult to trace. There has always been a desire, for commercial and other reasons, to employ a single inlet at one side of the pumps. This simplifies the construction, saves a great deal in first cost, makes the water-ducts more direct and free, and all parts more accessible. To accommodate this construction, seen in Mr. Gwynne's pump of 1850, there was difficulty in balancing the inclosed wheel—that is, compensating for the draft on the inlet side.

Open vanes, like those in the Andrews pump of 1839, avoid the thrust, but such vanes to be made of cast material require

a web or diaphragm to support them, and as soon as this was introduced the thrust became destructive, not only equaling the indraft or suction, but the whole area of the back of the disk or diaphragm became subject to a pressure equal to that in the discharge pipe.

There is a recognition of this difficulty by Mr. J. S. Gwynne in 1850, and his ingenious attempt to balance inclosed impellers by a vacuum or free space at the back. This is very complimentary to his engineering insight at the time, and it is a question now whether there is any true understanding among engineers of the function to be performed by the balancing chamber described in his patent of 1851. It seems to be a vacuum chamber to balance the draft of the suction, but is, in fact, to protect that much of the area of the back of the impeller from the pressure within the casing.



MAP OF ELECTRIC RAILWAY FROM GETTYSBURG TO BALTIMORE.

This subject was discussed in a paper read before the British Association, at Norwich, England, in 1868, by John and Henry Gwynne, and, since that time at least, open impellers have been a constant feature of their practice, and is no more than a return to the principle of the Massachusetts and Andrews pumps of 40 years before.

The adoption of open wheels or impellers, it was supposed, called for a double or balanced suction, as the single inlet forced the employment of an inclosed or double-disk runner. It was a cycle of experiment running over a period of 40 years, and ending where it began, if we do not include the form of the vanes.

Nothing has been said of French practice, and the writer must confess to some prejudice in the matter, because of certain reports about the year 1866, when there was a competitive test of some Gwynne pumps with those made by M. Coignard, of Paris. The Gwynne pumps were set down as working at a duty of 85 per cent., while the Coignard pumps realized nearly double the same effect. Looking at the construction in the two cases, and making such deductions as a fair inference would afford, we must conclude the report was of no value, and its statements impossible. Since then M. Farcot, of Paris, has produced some fine examples of centrifugal pumps for various purposes, some of them to operate against a head of 80 meters, and large pumps of excellent design, such as have been erected on the river Nile in Egypt.

French engineers have developed a good deal in compounding pumps, and, I believe, first invented the double or multiple impellers, one discharging into another, to be used in the case of high heads. I am not sure, however, whether Mr. Gwynne's compound pumps were first proposed or not. It is not a matter of much importance either way, because, all things considered, it is doubtful whether compounding is a construction to be recommended beyond certain exceptional cases. The problem involves questions not answerable by computation. It is one of mechanism and endurance, which future experience must determine, so that if added by our French friends to modern pump practice it must stand as a feature of questionable value.

While, as pointed out in the beginning, the invention of practical centrifugal pumps belongs in America, their development and application in an extensive way was for a long time mainly the work of English engineers. The draining of marsh and overflowed lands, and for graving docks, are the principal purposes to which the larger class of centrifugal pumps are applied, and neither of these wants had, down to 10 years ago, existed to any extent in the United States.

The draining, irrigation and reclamation of land, while it is to some extent owing to the physical circumstances of a country, is mainly a matter of the value of land and its scarcity. In some cases, as in California, to great fertility, but except on the Pacific Coast there has been until very recently no need of water-raising for these purposes, at least not enough to cause, as in Europe, a complete development of the most suitable machinery for the purpose.

At present there is a change going on. The cultivation of rice in the Southern States, and of cranberries and some other crops in the Northern States, the enhanced value of marsh land near large cities, and the greatly increased value of alluvial plains, begin to call for the development and improvement of water-raising appliances.—*Industry.*

(TO BE CONTINUED.)

ELECTRIC RAILROAD FROM GETTYSBURG TO BALTIMORE.

The sketch map herewith shows the location of an electric railroad which is intended to connect the now historic Gettysburg with Baltimore. To those unfamiliar with this section of country it should be said that most of the southern portion of Pennsylvania, indicated on the map, and a considerable part of Maryland lying between it and Baltimore, is very rich farming land, and is thickly settled. In the pre-railroad period, early in this century, turnpike roads were built through this region to Baltimore, and the produce in the section shown on our map and from far beyond it was hauled to Baltimore on what were known as Conestoga wagons, which were drawn by four, six, and sometimes eight horses. The writer recalls that in his schoolboy days these wagons passing through his native place—which was Hanover, and is indicated on the map—were a daily sight, passing up and down on the turnpike, shown by dotted lines. This road extended

from Hanover to Reisterstown, and also extended northward to Carlisle and Harrisburg, and connected with the whole system of turnpikes in Pennsylvania. Another similar road connected Gettysburg with Reisterstown, and from there a single line led to Baltimore. The amount of traffic on these roads, up to the fifties and sixties, was very large. After that period it was diverted to the railroads. The relation which Baltimore occupied to this country is very naïvely stated in Peter Parley's "First Book of History," published in the thirties. In that book the amiable historian said: "After seeing the rest of the city" (Baltimore) "you should go to Howard Street, where you will notice a great many wagons loaded with flour. Baltimore is the greatest flour market in the world. Thousands and thousands of barrels are brought here every year from various parts of Maryland, and from Delaware, Pennsylvania and Virginia. It is then sent in ships to New York, Boston, Charleston and various foreign countries."

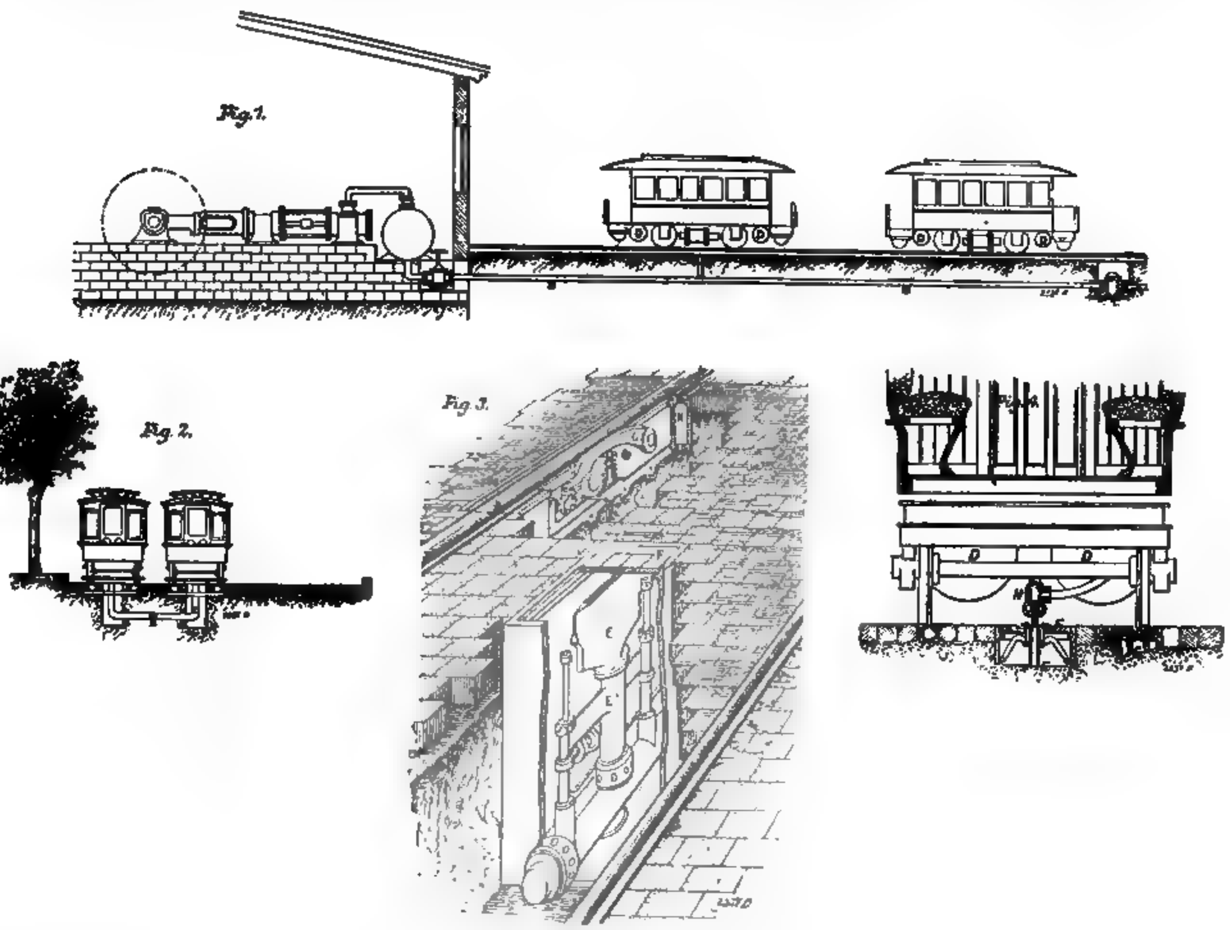
As remarked above, this trade was diverted from the turnpike roads to the railroads. An effort is about to be made to get some of it back. The present turnpike between Gettysburg and Baltimore, as explained, is shown by the heavy black line in the map. This, as will be seen, is nearly an air line between the termini; and this road is to be used in carrying out the project on account of its straightness and because of the many towns, large and small, that have grown up along it. The distance from Baltimore to Gettysburg by the proposed route is 50 miles, as against 72 miles by the steam railroads.

The parts of the line to be provided by different companies are: The Pimlico & Pikesville Line, 7 miles, opened in 1893 from Druid Hill Park, Baltimore, to Pikesville; the Pikesville, Reisterstown & Emory Grove Railway, 9 miles, from Pikesville to Reisterstown, with an extension of 1¼ miles to Emory Grove camp grounds. Contracts for this road were awarded last week.

The power house will be located at Owing's Mills; the Westminster & Union Mills Railway, 17 miles, from Reisterstown through Westminster to Union Mills; the Gettysburg Electric Line, 17 miles, from Union Mills through Littlestown, Pa., to Gettysburg. Several miles of this line are now built south from Gettysburg across the famous battle-field. This new line will afford excellent facilities to the many strangers and foreigners who annually visit the battle-field, and will be the means of bringing the territory between Westminster and Gettysburg into direct communication with Baltimore. The present means of reaching these points from Baltimore are by the turnpikes which form the route of electric lines, or by the Baltimore & Hanover, Hanover Junction, Hanover & Gettysburg steam railroads, which are controlled by the Western Maryland Railroad Company.

Owing's Mills, where the power house is to be located, was for many years connected with the Northern Central Railroad, which is located east of it by the Green Spring Branch—shown on the map. This was originally laid with old strap rails, and for a long time was operated by horses. The writer can recall a journey on this road in the fifties on the top of a four-wheeled coach-body car similar to those which were duplicates of the old cars used on the Mohawk & Hudson Railroad, and which were exhibited at Chicago last year. The motive power on the Green Spring Branch was a faithful mule.

New York and Philadelphia capitalists are said to be large holders of the bonds, and it is believed that the Widener-Elkins syndicate holds an interest in it.



METHODS OF DISTRIBUTING COMPRESSED AIR IN PARIS.

THE DISTRIBUTION OF COMPRESSED AIR IN PARIS.

In 1879 the first trials were made in Paris of what was afterward known as the Popp compressed air system; the earliest installation was on a very small scale, and for some years the application was limited to the operation of clocks in the streets as well as in private houses. The central station was located in a small building, in the basement of which were two compressors driven each by a 6 H.P. engine; on the first floor were the pressure regulators and other controlling apparatus, and a master clock which distributed pneumatic impulses at minute intervals throughout the system of air pipes.

In a few years, however, applications to obtain compressed air as a motive force became numerous from small users of power, and the rapid increase in demands rendered it necessary to increase the very modest installation in the Rue St. Anne. The first extension was completed in 1880, when the

Rue St. Fargeau works were started on a 60 H.P. basis. Anticipating rapid extension, Mr. Popp, had secured a site of nearly eight acres in the Rue St. Fargeau, and by 1887 no less than 5,000 H.P. were required to compress the air consumed. Fresh extensions followed, and large additional works were completed in 1892 on the Quai de la Gare. At present the development appears to be as follows:

1. Two central stations—those of St. Fargeau and the Quai de la Gare—representing together 13,000 H.P. From these two stations there were distributed through air mains in 1893 no less than 250,000,000 cubic yards of air.

2. Two central time stations for the operation of pneumatic clocks throughout Paris.

3. A *réseau* of 104 miles of mains, of which 41 are devoted to the time service, and 63 miles to the distribution of power for commercial uses; there is also a total length of the system of service pipes of 61 miles.

4. Sixteen refrigerating chambers in the basement of the Bourse du Commerce.

5. Two stations of about 1,000 H.P., used for generating electricity with compressed-air motors.

6. Twenty-eight hundred H.P. of compressed air consumed for 90 special installations.

7. Seventy-four hundred public and private clocks.

8. Three stations producing compressed air at high pressure, and representing about 1,800 H.P. These are intended for street railroad traction.

The Quai de la Gare works were designed for a total capacity of 24,000 H.P., divided into three groups. The first section of 8,000 H.P. is now at work. The air is compressed by four triple-expansion Corliss engines (2,000 H.P.), and steam is supplied by 20 Babcock & Wilcox boilers, divided into batteries of five. The compressors operate by stages, and have each two low-pressure and one high-pressure cylinder. The air is cooled during compression by spray injectors. The engines are vertical, and the compressors are driven from an overhead shaft.

The following are some particulars of the installation:

Number of sections in each boiler	12
" " tubes per section	9
" " " boiler	108
Length of tubes	17.3 ft.
Diameter of tubes	3.94 in.
Total heating surface of tubes per boiler	1,958 sq. ft.
Diameter of steam cylinders, high-pressure	33.47 in.
" " " " intermediate	53.18 "
" " " " low pressure	78.74 "
Air-compressing cylinders, "	43.31 "
" " high pressure	30.71 "

The boilers are registered for 170 lbs., and the working pressure is about 140 lbs. per square inch.

The compressors are arranged to deliver into the receivers at a pressure of 114 lbs. per square inch. The quantity of air actually compressed by the four engines per hour to 114 lbs. is equal to about 70,000 cubic meters, or 2,470,000 cub. ft., at atmospheric pressure. The air is compressed by each engine into two reservoirs having a capacity of 1,000 cub. ft., whence it flows into the principal air main, which is 19.69 in. in diameter. The sizes of the mains vary from this diameter to 11.8 in.; the larger are made of wrought iron welded; the smaller are of cast iron. The secondary mains range from 7.87 in. in diameter to 1.58 in.; the service pipes are of lead, and their diameters vary from 3.15 in. to 1.58 in.

When the station on the Quai de la Gare was undertaken the Creusôt Company, who supplied the engines, guaranteed as a maximum consumption of fuel 1.54 lbs. per I.H.P. per hour. The conditions of trials as laid down in the specifications were:

Duration of each trial	6 hours.
Number of revolutions per minute	50
Boiler pressure	163 lbs. per sq. in.
Effective pressure of compressed air	113 lbs.
Maximum indicated H. P.	2,000
Fuel	Briquettes d'Anzin.

An official trial was made only on January 19, 1893, about 18 months after the engines had been in constant work. The following figures give the principal results obtained:

Average number of revolutions per minute	50.685
" pressure of steam in boilers	163 lbs.
" " " at the admission valve of the high-pressure cylinder	146 "
Average vacuum in the condenser	29.35 in.
Pressure of air in compressors, low pressure	33.7 lbs.
" " " " high pressure	108 "
Temperature of the air when entering the low-pressure compressors	40.87 F.
Temperature of the air when leaving the high-pressure compressor	69 0 "
H. P. indicated	1996.5
Net fuel consumed per H. P. per hour	1.3 lb.

	Number of Revolutions per Minute.	Total Mechanical Efficiency.	Final Pressure of the Air.	Volume of Air at Atmospheric Pressure Compressed per Hour and per H.P.	Ratio of Actual to Theoretical Work in Compressing the Air.
		Per Ct	Lbs. per sq. in.	Cubic Ft.	
First trial made by the engineers of the Popp Company	50	84	74.67	353	1.281
Second trial made by Professor Gutermuth	40	80	85.33	365	1.192

Two trials, at an interval of three months, were made to test the efficiency of the engines and compressors, and the results tabulated above were, it is stated, arrived at.

It would appear, from these trials, that the mean total efficiency is 80.8 per cent. It is claimed that the actual cost of 100 cubic meters (3,530 cub. ft.) of air compressed to 113 lbs. per square inch is .4536 francs, or less than 5*d*. This figure was arrived at after a trial of 24 hours in the station of the Quai de la Gare, and it was confirmed by the results obtained from three months' subsequent working.

INDUSTRIAL APPLICATIONS OF COMPRESSED AIR IN PARIS.

	Less than 1 H. P.	H. P. 1 to 6.	7 to 12.	13 to 25.	26 to 50.	50.	100.	150.	
Lithographic printing-presses	34	25	2	1	....	....	....	....	62
Printing	6	4	....	....	2	2	....	....	14
Circular saws, etc	20	34	3	2	....	....	....	....	59
Cloth-cutting machines	29	2	..	....	....	....	....	....	31
Pumps	...	2	1	..	....	....	....	....	3
Mills	19	2	...	...	....	....	....	..	21
Lathes	58	51	9	..	....	....	....	..	118
Rolling mills	10	6	...	....	....	....	....	....	16
Refrigerators	3	1	3	....	....	....	....	....	7
Coffee-mills, roasters, etc	13	1	....	....	....	....	..	....	14
Cutting and drilling machinery	7	8	...	....	....	....	....	....	15
Mixing machinery	14	4	...	....	....	....	....	..	18
Sewing machines	53	7	.	....	....	....	....	....	60
Chopping machines, etc	92	7	...	....	....	....	....	....	99
Quilting "	5	1	...	....	....	.	....	....	6
Cutting "	9	1	...	....	....	....	....	....	10
Electrotyping machines	2	1	..	....	....	....	....	....	3
Embroidery "	10	..	...	....	....	....	....	....	10
Shearing, etc. "	5	1	...	....	....	....	....	....	6
Turbines and ventilators	6	11	...	....	....	....	....	....	17
Machines for carding and rolling	5	5	..	....	....	....	....	....	10
Comb factory	....	..	..	1	....	....	....	....	1
Dynamos	6	6	1	1	2	....	....	....	16
Machines for surgical and dental purposes	4	2	....	....	....	....	....	....	6
Soda-water factory	....	1	....	....	....	....	....	....	1
Provision merchants	3	1	....	....	....	....	....	....	4
Wood-working machinery	2	6	....	....	....	....	....	....	8
Cutting and polishing machinery	2	..	....	....	....	....	....	....	2
Envelope machinery	3	1	....	....	....	....	....	....	4
Boot machines	1	2	....	....	....	....	....	....	3
Motors	....		2	2	....	....	....	....	4
" for ventilating under stations	33	..	....	....	....	....	....	....	33
Motors for dynamos and cold stores	1	10	9	10	1	10	1	1	43
Lifting beer and wine	22	..	....	....	....	....	....	....	22
Elevators, luggage elevators	...	6	4	10	....	....	....	....	20
Blowpipes	96	.	..	....	....	....	....	....	96
Lace and trimming makers	4		...	...	...	....	....	....	4
Silk weaving	2	....	..	...	....	....	...	....	2
Total	509	209	24	27	5	12	1	1	798

The applications of compressed air in Paris are very numerous and varied, but according to the latest information the following classification may be made:

1. Distribution of power in quantities ranging from the minute time impulses to motors of 150 H.P. It is worth noticing that in many workshops old steam engines are now worked with compressed air, the boilers serving as reservoirs in which the air is heated before admission to the cylinders.

2. Ventilation and other sanitary purposes.

3. Refrigerators, especially cold stores for the preservation of meat, etc.

At the Bourse du Commerce the installation for this purpose is large, comprising 16 cold-air stores, containing together

5,800 cub. ft. Besides this, compressed air is used to drive motors for electric lighting; the exhaust from these motors is utilized to assist in reducing the temperature of the cold stores. Another series of motors at the Bourse installation is used for heating and ventilating purposes throughout the establishment.

4. The manufacture of ice as a by-product of the compressed air used as a motive power.

5. Elevating or lifting water and other liquids; this is applied chiefly to breweries, but there are large installations at the dépôts of Bercy and the Quai St. Bernard for lifting wines, spirits, etc.

6. Emptying cesspools (*using Retiro*).

7. Passenger and luggage elevators.

8. Pneumatic clocks on the boulevards in Paris and in about 2,000 private houses.

9. Mechanical traction on the Nogent tramways for a distance of about 8¾ miles. This application of compressed air is on the Mekarski system.

The table on page 467 gives an idea of many of the various uses to which compressed air has been put in Paris:

One of the most interesting applications of compressed air in Paris will be that for the propulsion of tram cars on the Conti system, a system already in experimental use, we believe, in Vienna. Some preliminary trials have been made at Nantes and at Nogent, and the results obtained sufficiently good to justify the Compagnie Générale des Omnibus to construct three lines in Paris, which will be opened for traffic during the present year. In the Conti system the air is compressed at a relatively high pressure at a central station; it is then admitted into the mains *B* placed beneath the rails (see diagram, figs. 1 and 2, on previous page).

Branches *C* lead the air nearly to the surface into automatic devices by which the car reservoirs can be charged. By this arrangement it is considered that one central station will be sufficient whatever the length of the line may be; and as the charging devices can be introduced at short intervals, the dead weight of reservoirs to be carried is relatively small. The distance between the charging stations varies according to the circumstances, but for convenience they should be located at the recognized stopping-places. Fig. 3 is a diagram that gives some idea of the arrangement. An iron box is sunk into the roadway to inclose the mechanism; the box is covered by a plate containing two hinged flaps *F* placed immediately over the air nozzle *E*. The nozzle is the continuation of a plunger working in the cylinder *E, I*, which can be placed in connection with the air main. As the front truck of the car passes over the rails it strikes the lever *G*, and, depressing it, opens a valve that admits air beneath the plunger *E*, raises it, and causes the air nozzle to push open the flaps *F* and rise above the level of the road. By the time it has reached its full height the nozzle engages in a connection, *H*, communicating with the reservoirs, which are filled in a few seconds. The valve is then closed, and as the car proceeds the lever *G* is released, the air beneath the plungers in the cylinder *E* escapes, and the nozzle falls, the flaps *F* closing over it and restoring the street surface. In the event of the mechanism becoming deranged, air standpipes are provided, so that the reservoirs can be charged by coupling up.

The results obtained will be watched with considerable interest; so, as soon as the system passes out of its experimental stage, which it promises to do shortly under the care of the Compagnie Générale des Omnibus.—*Engineering.*

THE HEATING POWER OF SMOKE.*

It appears to be generally supposed that a large percentage of fuel is lost in smoke, and random statements have been made to the effect that the loss in heating power due to the passing away of combustible matters in smoky furnace gases may reach as high as 30 per cent. of the whole. A little consideration, however, will show that the loss of any large percentage of combustible matter, and consequently of heating power, is quite out of the question. This may be proved in two ways: (1) by calculation of the two sources of heating power as shown by an analysis of coal or dross used for steam raising; and (2) by actual analysis of the furnace gases for combustible solids and gases.

In the following paper are given the results of these two methods of observation, the same dross being analyzed and also employed as fuel in a works furnace, from which smoky gases were given off which were tested for combustible matters.

1. The following is the analysis of the dross employed:

	Per cent.
Gas, tar, etc.	37.63
Fixed carbon	49.97
Sulphur	0.40
Ash	2.72
Water	9.28
	100.00
Heating power (practical) due to gas, tar, etc.	1.16
Heating power (practical) due to fixed carbons.	6.49
	7.65

The points to be observed are the relative proportions of heating power (represented in the analysis by the number of pounds of water 212° F. capable of being evaporated to dryness by 1 lb. of fuel) given out respectively by the combustion of gas, tar, etc., and by the fixed carbon. These are calculated according to Playfair's well-known formula, which was practically tested on coals intended for the British Navy, and which shows that while 1 lb. of fixed carbon is capable when burned of evaporating 13 lbs. of water at 212° F. to dryness, 1 lb. of the gas, tar, etc., will only evaporate 3.1 lbs. From these figures it appears that in the coal or dross, the gas, tar, etc., only contribute 15 per cent. of the total heat given out during the combustion, and that the fixed carbon produces the remainder, or 85 per cent. In coals with less of the former ingredients and more of the latter, which is commonly the case, the proportion given out by the volatile constituents would be considerably reduced. It is thus perfectly clear that even though the whole of the volatile matters (which can alone be accountable for any loss of combustible material) escaped combustion, there could not possibly be a greater loss of heat than 15 per cent. of the whole, even in such an extreme case as this represents.

2. An analysis was made of the furnace gases given off during the burning of the dross of which the results are given above, with the following results:

	Gases very smoky. Per cent. by volume.	Gases almost free from smoke. Per cent. by volume.
Carbonic acid	5.0	3.5
" oxide	none	none
Hydrocarbons	trace	none
Nitrogen	79.9	79.9
Oxygen	15.1	16.6
	100.00	100.00

It has been asserted that carbonic oxide is given off in considerable quantity when much smoke is being produced, but it does not appear in this case; and Hempel, in his work on "Gas Analysis," comes to the conclusion that little or no combustible gases are present in furnace gases. He says: "Furnace gases usually contain only carbon dioxide, oxygen and nitrogen. All other gases are present in but very small amounts. In oft-repeated analyses the author has always found only traces of carbon monoxide, methane and the heavy hydrocarbons." This is in complete accord with the analyses given above, and it may be taken for granted that the presence of carbonic oxide or other combustible gases in furnace gases is a most unusual occurrence. This is quite conclusive evidence that no appreciable loss of heat, even when the furnace gases are smoky, can be attributed to the passing away of the products of imperfect combustion in the gaseous form at least.

That there is loss of combustible matter in the smoke is an undoubted fact, but the quantity seems also to be greatly magnified in certain random statements. In the experiment referred to above the soot was also collected during one hour and a half with the following results:

	Grains per 100 cub. ft. of furnace gases.
Carbonaceous matter	30.81
Ash or mineral matter	20.65
Total soot	51.46

It will be observed that the soot collected consisted largely of mineral or incombustible matter. In several experiments to estimate the soot in furnace gases similar results to those were obtained, and the average would come very close to the quoted results of this special test.

To find how much carbonaceous matter was actually lost as smoke, it will be necessary to know the number of cubic feet of furnace gases given off by the combustion of, say, one ton

* R. R. Tatlock, in the *Chemical News.*

of the dross. If the percentage of carbonic acid in the furnace gases is taken at 5 per cent., the total volume of these given off from one ton of dross would be about 940,000 cub. ft. measured at the ordinary temperature and pressure, and this would contain 41 lbs. of carbonaceous matter and 27 lbs. of mineral matter. This would represent 1.8 per cent. of the volatile matters (gas, tar, etc.), given in the analysis of the dross; and if from this is now calculated the heating power according to Playfair's formula, it will only come to 0.057. This figure, compared with the practical heating power (7.65) of the dross, goes to show that the solid combustible matter of the smoke can only account for the very small percentage of 0.74 of the total heating power which can be obtained from the coal.

From the results of these experiments it is evident that the loss of combustible matters in smoke is very small indeed, and that the belief in immense loss by this cause is simply a fallacy, and it is decidedly not corroborated by experiment. In adopting methods of removing the smoke nuisance, it must therefore be borne in mind that there is little or no gain in burning smoke, and that other methods of dealing with the problem, such as Dulier's smoke absorption process, ought also to receive consideration.

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

THE object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publications will in time indicate some of the causes of accidents of this kind, and to help lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with the information which will help make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a great favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in August, has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS IN AUGUST.

Sioux City, August 2.—Two freight trains on the Chicago, Milwaukee & St. Paul Railroad collided on a bridge at this point. The engineer and fireman jumped and escaped with slight injuries.

Lafayette, Ind., August 3.—Two freight engines on the Wabash Railroad collided near here to-day, and Engineer Clarke was killed.

Field, Man., August 3.—The boiler of a locomotive on the Canadian Pacific Railway exploded near here to-day. The engineer, B. Wheatly, and fireman, A. Hunt, were instantly killed.

Cumberland, Md., August 3.—A coal train was wrecked at Mud Cut, on the Cumberland & Pennsylvania Railroad, to-day. The engine jumped the track and ran against a bank and turned upside down. The engineer was beneath the engine, and with the exception of a few bruises about the face was unhurt; the fireman sustained a slight injury.

Wittenberg, Wis., August 3.—Charles Heulin, engineer on the Milwaukee, Lake Shore & Western Railroad, was killed while at work under his engine early this morning; another freight train backed in against the rear of his freight train, forcing the engine forward and crushing the man under the fire-box.

Urbana, O., August 3.—A passenger train on the New York, Pittsburgh & Ohio Railroad struck a freight car on a siding this morning. Joe Dano, the engineer, was internally injured, and Fireman James Douglas slightly hurt.

Warren, Pa., August 3.—A passenger train on the Dunkirk, Allegheny Valley & Pittsburgh Railroad was ditched here this afternoon. Engineer Beardsly was scalded about the head, and Fireman Robbins was cut on the forehead.

Akron, O., August 3.—A collision occurred between two freight trains on the New York, Pennsylvania & Ohio Railroad to-day. Engineer M. Stack was crushed to death, and his fireman, John Shoop, badly scalded.

Rochelle, Fla., August 4.—A mixed train on the Florida Southern Railroad plunged into a lime sink near here this morning. The engine and two cars were completely wrecked. Engineer Rampaner was seriously injured.

Lima, O., August 4.—A freight train on the Pittsburgh, Fort Wayne & Chicago Railroad ran into an open switch at this point to-day. The engineer and fireman were somewhat bruised.

Cincinnati, O., August 5.—A Panhandle freight was wrecked at Crestonville to-day by running over a cow. The fireman, M. Neil, was killed, and Engineer Egan was slightly injured.

Grand Junction, Col., August 8.—A head-end collision occurred on the Rio Grande Western Railway to-day, in which Fireman Pickering was killed; the engineers of the two engines were seriously scalded.

Des Moines, Ia., August 8.—A cinder dropping from a locomotive on a bridge at Peru caused a smouldering and burning of the main stringers to such an extent that a train on the Chicago Great Western Railroad was wrecked by the collapse of the structure. The engineer and fireman were both killed.

Omaha, Neb., August 9.—A northern-bound passenger train on the Chicago, Rock Island & Pacific Railway plunged over a 50-ft. trestle 4 miles north of Lincoln to-night. Isaac Depew, the engineer, and William Craig, fireman, were killed. Train-wrecking is suspected.

Tacoma, Wash., August 10.—There was a head-end collision on the Northern Pacific Railroad about 15 miles from this city to-day. Engineer L. H. Harmon was instantly killed, and his fireman, E. Martin, was so seriously injured that he died. The accident was the result of an order given by the train despatcher.

Philadelphia, Pa., August 10.—Joseph Haas, an engineer on the Philadelphia & Reading Railroad, fell from his engine to-day and fractured several ribs.

Kansas City, Mo., August 10.—A passenger train on the Southern Kansas branch of the Atchison, Topeka & Santa Fé Railway ran into the rear end of a stock train just east of Olathe to-night. The engineer and fireman were injured by jumping, the fireman's leg being broken and his head and body being badly bruised. Engineer Comstock escaped with a few cuts and bruises and a badly crippled hand.

Mt. Sterling, Ky., August 11.—The engine on the fast train of the Cincinnati Railroad broke a front truck just south of Barren Fork to-day. The engineer and fireman were slightly injured.

Topeka, Kan., August 12.—A collision occurred between two freight trains on the Atchison, Topeka & Santa Fé Railroad, at Hurdland, Mo., to-day, in which Engineer Humphrey was killed. On evidence given by his fireman after the collision, it is probable he died of fright. His evidence was: As they approached the Hurdland switch he moved to Humphrey's side of the cab and said: "Was it not at Gibbs we had orders to stop?" Just then the headlight of the west-bound train showed around the curve. Humphrey said not a word nor moved hand or foot, but looked straight ahead with glassy eyes at the other engine, which was moving at a terrific rate. The fireman spoke to him again, but still the engineer did not move, and the fireman to save his life jumped. The other engineer and fireman reversed their engine and saved themselves by jumping.

Portsmouth, N. H., August 12.—The locomotive on the morning passenger train on the Boston & Maine Railroad jumped the track just outside the depot here to-day. Engineer Dunbar received some injuries about the back and hip, and a fireman by the name of Story was cut about the head and arms.

Charlotte, N. C., August 13.—Charles Briggs, the engineer on the Southern Railway, was struck by a passing train as he stepped off his engine this morning; he was instantly killed.

Buffalo, N. Y., August 13.—A Lehigh Valley freight train ran into a Buffalo Creek freight engine near the city limits to-day. Both were backing at the same time, and the morning was densely foggy. George Pitts, one of the engineers, was slightly hurt about the back.

Albuquerque, N. M., August 16.—A passenger train on the Atlantic & Pacific Railroad was wrecked by a washout at Cubero this morning. The engine was ditched, and James H. Orton, fireman, was killed, and William Norris, engineer, was dangerously injured.

South Whitley, Ind., August 16.—A freight train on the Cumberland, Wabash & Michigan Railroad was run into at a crossing here by a Wabash freight train. The engineer and fireman of the latter train jumped and were slightly injured.

Owensburg, Ky., August 17.—A freight train on the Hardensburgh branch of the Louisville, St. Louis & Texas Railroad was wrecked to-day. Fireman Wick Dehannen was fatally injured.

Sioux City, Ia., August 17.—A fast freight on the Sioux City & Pacific Railroad ran into a box car at River Sioux to-day. The engine and six cars went down an embankment, and Engineer Moorey and Fireman McKenney were badly injured.

LOCOMOTIVE RETURNS FOR THE MONTH OF JUNE, 1894.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage.					Av. Train.		Coal Burned per Mile.						Cost per Locomotive Mile.							Cost per Car Mile.		Cost of Coal per Ton.
			Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Passenger Cars.	Freight Cars.	Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Passenger.	Freight.	
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Atchison, Topeka & Santa Fé	863	782	....	....	1,496,125	1,755,171	2,911	....	....	....	....	....	86.06	....	...	4.33	8.98	0.21	1.46	6.88	0.19	21.94	...	...	1.90
Canadian Pacific	604	....	467,635	726,084	194,936	1,389,645	2,300	....	....	....	....	...	61.25	....	....	2.30	9.35	0.30	....	5.62	1.26	18.83	....	....	3.08
Chic., Burlington & Quincy	541	...	....	....	....	1,284,127	2,373	4.98	20.23	....	....	....	78.11	....	.	4.34	7.96	0.17	0.17	6.87	0.04	19.55	....	....	2.04
Chic., Milwaukee & St. Paul	855	....	....	....	....	2,235,682	2,626	....	...	....	....	....	52.68	....	....	3.89	7.97	0.26	...	6.98	...	19.05	....	....	3.00
Chic., Rock Island & Pacific	564	....	479,996	779,387	297,830	1,557,213	2,565	5.50	18.20	49.04	62.40	36.04	49.16	9.16	3.82	2.77	5.32	0.23	2.77	6.14	0.42	17.65	....	....	2.40
Chicago & Northwestern	....	....	805,993	1,236,043	597,007	2,639,043	....	....	....	....	....	....	73.21	....	....	3.56	8.60	0.28	....	6.31	0.88	19.63	....	....	....
Cincinnati Southern	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	...	...	...	...	....	....	....	...	....	....
Cumberland & Penn.*	23	22	8,615	14,898	....	23,513	1,022	....	....	....	....	....	68.45	....	...	3.59	3.17	0.38	....	...	2.66	9.75	...	....	....
Delaware, Lackawanna & W. Main L.	213	200	71,675	694,607	5,450	771,732	3,858	....	....	..	....	....	90.77	....	....	2.68	6.88	0.40	....	5.68	....	15.64	...	....	1.50
Morris & Essex Division	163	....	180,090	145,351	101,615	427,056	2,619	....	....	....	....	....	60.53	....	....	3.81	9.50	0.38	....	6.38	....	20.07	...	....	3.10
Flint & Père Marquette	....	....	87,170	55,088	53,588	195,846	2,577	....	....	....	....	....	26.05	....	....	3.07	5.38	0.15	...	5.23	0.90	14.68	....	....	1.85
Hannibal & St. Joseph	68	....	68,784	112,617	31,823	218,224	3,231	4.88	16.68	....	....	....	67.47	18.25	5.04	2.45	5.91	0.09	0.24	6.73	0.08	15.45	....	....	1.85
Kansas City, Ft. S. & Memphis	150	....	91,621	198,909	83,502	369,062	2,929	....	....	....	....	....	65.75	....	....	2.92	3.56	0.20	0.39	7.22	...	14.29	....	....	1.14
Kan. City, Mem. & Birm	42	36	26,752	46,463	10,759	83,974	2,333	....	....	..	....	....	69.48	....	....	3.14	3.14	0.28	0.30	7.35	....	14.21	....	...	0.87
Kan. City, St. Jo. & Council Bluffs	...	....	51,051	39,044	39,800	129,895	3,608	5.01	23.07	....	....	. ..	63.23	12.83	3.89	3.23	6.16	0.18	0.10	6.32	0.04	15.98	....	...	2.04
Lake Shore & Mich. Southern	592	....	869,189	612,865	339,252	1,321,306	2,231	....	....	54.23	83.02	21.49	62.18	....	....	3.36	7.80	0.12	0.17	6.88	0.05	18.38	....	....	2.50
Louisville & Nashville	....	....	....	....	....	....	...	.. .	....	....	...	....	....	....	....	..	....	....	....	....	....	....	...	....	....
Manhattan Elevated	....	295	740,477	....	65,202	805,679	3,781	....	....	....	....	....	37.73	....	....	2.40	7.60	0.20	....	9.10	...	19.30	....	....	4.08
Mexican Central	148	135	...	....	....	415,285	....	.	...	....	....	....	65.50	....	....	5.25	11.80	0.48	....	4.91	0.10	22.54	...	....	3.55
Minn., St. Paul & Sault Ste. Marie	107	77	79,267	78,033	31,893	189,198	....	5.02	19.86	....	....	....	53.54	....	....	2.36	7.90	0.24	....	6.76	....	17.26	3.02	1.07	....
Missouri Pacific	....	351	....	....	848,129	....	2,914	4.26	17.12	....	....	....	80.48	....	....	5.43	6.11	0.32	1.38	6.42	1.54	21.18	4.15	1.54	1.48
Mobile & Ohio	107	82	54,891	146,095	50,465	251,451	3,148	....	....	....	....	...	63.80	....	....	2.17	4.61	0.21	0.70	5.59	1.08	14.36	....	....	1.48
N. O. and Northeastern	....	....	....	....	....	....	...	...	....	....	....	....	....	....	....	...	....	....	....	....	...	...	....	....	. .
N. Y., Lake Erie & Western	....	625	431,671	755,607	225,352	1,412,630	2,580	4.50	25.10	90.70	140.70	81.90	104.40	20.20	5.60	4.24	8.54	0.35	1.84	7.43	1.21	23.61	....	....	1.60
N. Y., N. H. & H., Old Colony Div	....	....	409,172	166,732	192,119	....	....	4.00	17.00	....	....	....	60.18	15.50	5.00	3.53	9.04	0.55	....	6.97	0.71	20.80	....	....	...
N. Y., Pennsylvania & Ohio	281	....	128,307	328,528	123,710	580,545	2,065	5.30	19.90	63.40	119.50	120.40	134.40	11.90	6.10	4.14	10.40	0.30	1.96	7.39	1.18	25.39	....	. ..	....
Norfolk & Western, Gen. East. Div.†	....	....	93,627	331,374	51,678	476,679	2,979	5.18	20.90	47.66	114.69	....	67.76	9.20	5.48	4.98	3.36	0.26	....	....	....	8.60	....	....	3.20
General Western Division†	....	....	103,293	412,409	60,420	576,122	3,081	5.01	16.49	73.00	127.00	....	119.00	14.56	7.72	10.98	3.69	0.28	....	....	....	14.85	....	....	....
Ohio and Mississippi	....	...	....	....	.... .	....	....	....	....	....	....	....	....	....	...	....	....	....	....	....	....	...	....	....	....
Philadelphia & Reading	....	...	430,438	792,886	445,093	1,668,417	3,391	....	....	....	....	....	76.70	...	...	4.80	4.62	0.36	....	5.77	0.42	15.97	....	....	...
Southern Pacific, Pacific System	....	....	....	....	....	....	....	....	. . .	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Union Pacific	867	....	478,480	866,053	332,384	1,676,917	3,299	6.15	18.47	....	....	....	91.53	15.60	6.90	8.74	9.43	0.38	....	8.11	1.15	27.81	4.36	1.99	2.05
Wabash	...	...	....	....	....	....	...	....	....	....	....	....	...	....	...	....	...	....	....	....	....	....	....	....	....
Wisconsin Central	149	108	142,065	150,469	73,746	366,280	....	....	....	....	....	....	62.30	....	....	2.67	9.11	0.15	....	7.04	....	18.97	...	....	2.91

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars. Empty cars which are reckoned as one loaded car are not given upon all of the official reports, from which the above table is compiled. The Union and Southern Pacific, and New York, New Haven & Hartford rate two empties as one loaded; the Kansas City, St. Joseph & Council Bluffs and Hannibal & St. Joseph Railroads rate three empties as two loaded; and the Missouri Pacific and the Wabash Railroads rate five empties as three loaded, so the average may be taken as practically two empties to one loaded

* Switching engines allowed 6 miles per hour; wood, construction and gravel trains, 10 miles per hour.

† Wages of engineers and firemen not included in cost.

Lexington, Ky., August 18.—A fast Florida train on the Cincinnati & Southern Railroad was wrecked by a misplaced switch at Brannon. The engineer and fireman were seriously injured.

Worcester, Mass., August 18.—There was a head-end collision between an Adams Express train and an accommodation train at this point to-night. The engineer of the Adams Express train did not see the red light placed on the west-bound track to protect the accommodation train while the latter ran over the cross-over. He was slightly injured.

St. Louis, Mo., August 19.—A freight train on the Wabash Road struck a horse 2 miles west of Jonesborough, killing Engineer C. Welton, and Fireman Ray Tilton was so badly injured that he subsequently died.

St. Louis, Mo., August 20.—A fast express on the Vandalia Line was ditched near Pocahontas this evening. Engineer Manafee and Fireman Dickinson were seriously injured. The cause of the wreck is unknown.

Haynes Falls, N. Y., August 20.—A collision occurred between a wild engine and that of a passenger train on the Ulster & Delaware Railroad, at Stony Clove, to-night. The engineer and fireman jumped and were slightly injured.

San Antonio, Tex., August 20.—A fast train was wrecked on the Southern Pacific Railroad near Eldridge. Charles E. Ford, the fireman, was killed.

Dunkirk, N. Y., August 20.—An engine on the Dunkirk, Allegheny Valley & Pittsburgh Railroad was wrecked by a misplaced switch to-day. The engineer jumped and was quite badly bruised.

Ellenburg, Wash., August 20.—A freight train was wrecked on the Seattle, Lake Shore & Eastern Railway, near Latona, this evening, by striking a cow. The engine was thrown into a ditch, and the tender ran into the back end of it, killing Fireman J. Black; the engineer was somewhat injured.

Colorado Springs, Col., August 21.— A freight train on the Colorado Midland Railroad was wrecked by a landslide 10 miles from Idlewild. Engineer John B. Blocker was instantly killed.

Huntington, Pa., August 24.—There was a collision between two heavily loaded freight trains on the Pennsylvania Road near here this morning. Engineer Preston had both legs severed from the body, and they were subsequently found in a burning fire-box. He died from the result of his injuries.

Parkersburg, W. Va., August 27.—A passenger train on the Baltimore & Ohio Railroad ran into a boulder near Cairo this morning, throwing the engine from the track. Fireman Shaughnessy was killed, and Engineer Flannery was fatally injured.

Chicago, Ill., August 27.—A passenger train on the Chicago & Eastern Illinois collided with a switch train at Thirty-seventh Street to-day, fatally injuring the fireman.

Ottumwa, Ia., August 30.—There was a collision between two freight trains on the Chicago, Burlington & Quincy Railroad, near Cleveland. Gus Starkman, the engineer, was instantly killed, and Ed. Walker, a fireman, fatally injured.

Springfield, Ill., August 30.—A freight train ran into an open switch near Dawson this evening. Engineer Atkinson and his fireman were badly injured, the engineer probably fatally.

Grand Rapids, Mich., August 31.—A fast passenger train on the Chicago & West Michigan Railroad ran into a couple of cows south of Baldwin to-day. The engine was overturned, and Engineer John S. Patterson so badly injured that he died shortly afterward. John Kobe, of Grand Rapids, was instantly killed by being crushed under the engine.

Our report for August, it will be seen, includes 41 accidents, in which 17 engineers and 15 firemen were killed, and 22 engineers and 15 firemen were injured. The causes of the accidents may be classified as follows:

Boiler explosion	1
Broken truck	1
Cattle on track	4
Cave-in	1
Collisions	14
Crushed under engine	1
Derailments	3
Falling from engine	1
Landslide	2
Misplaced switch	4
Struck by passing train	1
Struck car on siding	2
Train-wreckers	1
Trestle burned	1
Unknown	3
Washout	1
	41

PROCEEDINGS OF SOCIETIES.

Master Car Builders' Association.—The Secretary has just issued a circular giving the subjects and committees for the convention that is to be held in June, 1895. The subjects and the chairmen of the committees are as follows:

1. Interchange of Cars.—To suggest how cars in interchange may be maintained equitably to owners and operators with the least expense and detention. Chairman, Pulaski Leeds, S.M.P., Louisville & Nashville Railroad, Louisville, Ky.

2. Road Tests of Brake Shoes.—To conduct and report upon a series of comparative tests of different brake shoes in service, with as complete data as possible. Chairman, R. H. Soule, S.M.P., Norfolk & Western Railroad, Roanoke, Va.

3. Laboratory Tests of Metal for Brake Shoes.—To conduct and report upon laboratory tests of different brake shoes, with as complete data as possible. Chairman, S. P. Bush, S.M.P., Pennsylvania Company, Southwest System, Columbus, O.

4. Lubrication of Cars.—Continued from 1894 to pursue its own recommendations as to tests of oil for lubrication, and to consider the economics of journal bearings as suggested in this report if feasible. Chairman, A. M. Waitt, M.C.B., Lake Shore & Michigan Southern Railway, Cleveland, O.

5. Air-brake Tests.—Chairman, G. W. Rhodes, S.M.P., Chicago, Burlington & Quincy Railroad, Aurora, Ill.

6. Air-brake and Hand-brake Apparatus on Cars.—Continued from 1894 to consider the questions raised in its report, and to include the standard levers and all other questions of importance pertaining to the subject. Chairman, E. D. Bronner, M.C.B., Michigan Central Railroad, Detroit, Mich.

7. Automatic Couplers.—To advise what changes may be desirable in the standard size of M. C. B. automatic coupler shanks, and to recommend a standard yoke or pocket strap for rear-end attachments to cars. Chairman, J. M. Wallis, Mech. Supt., Grand Trunk Railway, Montreal, Can.

8. Mounting New and Second-hand Wheels.—To report upon the best method of mounting new and second-hand wheels so that they may be properly located upon the axle. Chairman, J. N. Barr, S.M.P., Chicago, Milwaukee & St. Paul Railroad, Milwaukee, Wis.

9. Passenger Car Ends and Platforms.—To consider what improvements may be made in the construction of passenger ends and platforms for increased strength in ordinary service and emergencies. Chairman, E. W. Grieves, M.C.B., Baltimore & Ohio Railroad, Baltimore, Md.

10. Coal Car Sides.—To suggest best methods of construction and staying of the sides of 60,000-lbs. capacity coal cars with high sides. Chairman, R. E. Marshall, S.M.P., Philadelphia, Wilmington & Baltimore Railroad, Philadelphia, Pa.

He has also issued a notice calling the attention of the members to the wheel gauges. This circular states that in seeking to make arrangements with gauge manufacturers to furnish the gauges recently adopted, the Executive Committee finds that in order to make the most satisfactory arrangements as to prices it is desirable to have some idea as to how many sets of gauges will be ordered soon. If as large a number as 50 sets of each kind can be guaranteed, the manufacturers' prices will be much lower. The gauges comprise: 1. Maximum and minimum wheel flange thickness gauge. 2. Check gauge for mounting wheels. 3. A set of nine journal-bearing and wedge gauges. If 50 sets of each kind can be guaranteed to manufacturers, the prices will not exceed the following figures: For No. 1, $6.30; No. 2, $31.50; No. 3, $40.50.

American International Association of Railway Superintendents of Bridges and Buildings.—The committee appointed by this Association to report on the subject of Depressed Cinder-pits and Other Kinds have issued a circular of inquiry asking for information on this subject. The questions asked are: What system for dumping and removing ashes from locomotives is in use on your road? Give general description and the location, whether in a main track, side track, or special track. If a pit is used, give depth, clear width and length, and describe in general the kind of foundation, materials in side wall and bottom of pit, coping, rail fastenings or supports, drainage, and the methods used to protect against heat. If a conveyor system, elevated platform with dumping trestle, or other method in use, describe same, giving principal dimensions, materials and details. What is the arrangement, location and height of ash-car track in relation to the pit or dumping track? What kind of coal is used? Does the choice or dimensions of a cinder-pit system depend to a certain extent on the kind of coal used, and, if so, in what respect? It is particularly desired to obtain first cost of cinder-pits or other systems for removing ashes; also the unit cost of operation—*i.e.*, handling the ashes from pits to cars—and the

output capacity of a pit or plant of given size. We are especially desirous of obtaining blue prints of cinder-pit systems in actual use on your railroad, with such remarks as you may feel willing to make on the efficiency of the design, the reasons for its adoption, and any possible improvements you might have to suggest or general views to offer on the subject of the best system to recommend under stated conditions. The committee is composed of the following members: Walter G. Berg, Lehigh Valley Railroad, Jersey City, N. J.; Abel S. Markley, Pittsburgh & Western Railroad, Alleghany, Pa.; George W. Andrews, Baltimore & Ohio Railroad, Philadelphia, Pa.; R. M. Peck, Missouri Pacific Railroad, Pacific, Mo.

New York Railroad Club.—The first meeting of the season was held at the rooms of the American Society of Mechanical Engineers on Thursday evening, September 20. Mr. W. W. Wheatley, Car Accountant for the West Shore Railroad, read a paper on the Best Way of Improving the Present Methods of Rating Train Loads. He called attention to the fact that the present method of rating was very deficient in that it was on the basis of loaded car, and the load in a nominally rated car might be anything from a load of butter, as was instanced in one case, to a full complement of 30 tons. It was evident, therefore, that unless some method was devised for giving dispatchers and yardmen the necessary information to enable them to load a locomotive with a proper load in tons, the weight of the train might continue to vary between very wide limits. In the discussion that followed the stand was taken that this rating by weight should be put in execution in all instances of west-bound as well as east-bound freight to be so rated, as cars must be hauled westward at any rate, and it mattered little whether freight was distributed through a dozen cars giving each a load of 2 tons, or whether it were all loaded in one car. In reply to this it was maintained that if the west-bound trains were loaded by weight, longer trains could be hauled than the east-bound engines could handle, so that fewer train crews would be needed going west, and those that had been carried over the road eastward could be sent back, deadhead, on passenger trains at a less expense than if they were in charge of freight.

OBITUARY.

James Nelson Lander.*

The death of J. N. Lander, the well-known Superintendent of Motive Power of the lines of the New York, New Haven & Hartford Railroad east of Hartford, Conn., occurred at his home in Concord, N. H., on Tuesday, August 28. His appearance at the June conventions held in Saratoga then filled all his friends with apprehension, as it was evident that disease had taken a strong hold on his generally robust constitution.

He was born in Topsham, Vt., on May 29, 1838, and was the son of George and Jean (Laird) Lander, and was educated in the public schools of his State.

At the age of 15 years he entered the machine shop of A. Latham, at West Lebanon, as an apprentice, and he there started on his subsequent career in the mechanical world. He remained at West Lebanon for about 10 years, and then went to Concord, N. H, in the employ of the Northern Railroad as Foreman in the machine shops of that company.

In 1865 he succeeded Mr. James Sedgely as Master Mechanic of the Northern Railroad, and held the position until 1881, when the Concord and Boston & Lowell railroads, having consolidated under a business arrangement, he was appointed Master Mechanic of the two roads. This agreement was subsequently annulled by the courts, and he was then offered and accepted the position of Superintendent of Motive Power of the Mexican Central Railroad, then in process of construction. He remained in Mexico only about a year, however, and then returned to New England and received the appointment of Superintendent of Rolling Stock of the Old Colony Railroad, and upon the consolidation of that system with the New York, New Haven & Hartford Railroad, he was continued as Superintendent of Motive Power of all the lines embraced by the new system east of Hartford. This position he held at the time of his death.

The fact that for many years he was connected with the Fire Department of Concord will furnish a key to his character, or, rather, his disposition, which was shown by a strong liking for companionship. Wherever he was found, if there were any acquaintances within reach, he was the center of a circle which was always entertained by his vivacity and the expressions of his strong convictions, which he seldom hesitated to utter.

In 1870 he became a member of the American Railway Master Mechanics' Association, and was ever afterward active and interested in its proceedings. Nearly every year he served on one or more committees of investigation, and always devoted much time and thought to the work which he was appointed to do. He was made a Vice-President in 1877, and held that office until 1881, when he was elected President, and served in that capacity for two years. He was also for a number of years a representative member of the Master Car Builders' Association, but his name does not appear in the recent lists of members of that association, probably for the reason that when the Old Colony Line was consolidated with the New York, New Haven & Hartford Line, the car department of the former was placed under the jurisdiction of another head.

At the time of his death he was chairman of a committee appointed to confer with the American Railway Association, with reference to securing the required money for making shop tests of locomotives at Purdue University. His services in that connection will be sadly missed. The duties entrusted to that and to another committee, which it is expected will conduct a series of such tests, are of a very responsible character, and unless the work which is proposed is very wisely managed, serious dissatisfaction may result.

Of Mr. Lander's professional career it may be said that the general attitude of his mind leaned toward conservatism. He was not much attracted by brilliant invention or startling novelties. Like many other people, he always had a great deal more confidence in things which had been done than in those which only held out the promise of important results. When the success of any new enterprise was assured, he was always ready to take it up. He was greatly interested in compound locomotives; and it was through his patronage that Mr. F. W. Dean was able to develop his designs into actual practice. Mr. Lander was apparently a strong believer in the compound system, but at the same time was disposed to move slowly in its adoption.

He always held very decided views on all subjects, especially in politics, and was a stanch Republican, and represented one of the wards of Concord in the Legislature of New Hampshire for two terms. Ever since he lived in Boston he was a resident at the United States Hotel, where he could usually be found during the evening occupying what was jocularly called the "Ananias Corner," where he received and entertained any of his friends who were within reach. He took an active part in the Proceedings of the New England Railway Club, of which he was a member. He will hereafter be sadly missed by the members of all the organizations to which he belonged.

He leaves a wife and one son, George N. Lander, who is an electrical inspector in the employ of the New Hampshire Board of Fire Underwriters. The burial was in Blossom Hill Cemetery, near Concord, and the funeral was attended by many prominent railroad officers and other old friends.

John Newell.

The news of the death of John Newell, President and General Manager of the Lake Shore & Michigan Southern Railway, who died at Youngstown, O., on August 27, reached us too late to be announced in our last issue. Of his life and death it was said in the *Travellers' Official Guide*:

"His death was the result of a slight stroke of paralysis, undoubtedly caused by overwork. Mr. Newell was 62 years old at the time of his death. He occupied a position of influence far greater than was necessarily connected with the important offices which he held. His will was most indomitable, and his capacity for business was enormous. He entered the railway service in 1846 as a rodman, and was afterward Assistant Engineer of the Central Vermont Railroad. In 1851 he worked on the extension of the Champlain & St. Lawrence Railroad, and in 1852 and 1853 he surveyed the routes of railroads from Louisville to Cincinnati and from Saratoga to Sackett's Harbor, N. Y. In 1855 he was Engineer of the old Cairo City Railroad, and from 1856–65 Engineer of Maintenance of Way of the Illinois Central Railroad. From 1865–68 he was President of the Cleveland & Toledo Railroad, now a part of the Lake Shore, and during the next succeeding year Engineer and Superintendent of the New York Central. From 1869–71 he was Vice-President of the Illinois Central and for 3 years after that President of the same road. In 1875 he became General Manager of the Lake Shore, and since 1883 he

* For many of the following facts relating to his life, we are indebted to a Concord paper.

has been both President and General Manager of the same road. At the time of his death he was also President of the Pittsburgh & Lake Erie Railroad."

Mr. D. W. Caldwell has been elected General Manager of the Lake Shore Road to succeed Mr. Newell. It is understood that Mr. Caldwell will eventually succeed to the presidency.

PERSONALS.

MR. W. H. THOMAS is hereby appointed Assistant Superintendent of Motive Power, with jurisdiction over both the Eastern and Western systems. All officers and employés in the motive power department will obey his instructions.

R. D. WADE, Superintendent of Motive Power of the Southern Railway Company, has had his jurisdiction extended to include the Eastern system. The assistant superintendents of motive power and master mechanics will report and receive their orders from him; road firemen of engines, as well as engineers and firemen, are under his control, and report to him through the master mechanics in all matters relative to the condition of locomotives; but in matters pertaining to the discipline on the road they are under the direction and control of the superintendents, who have full authority to suspend or discharge them.

Manufactures.

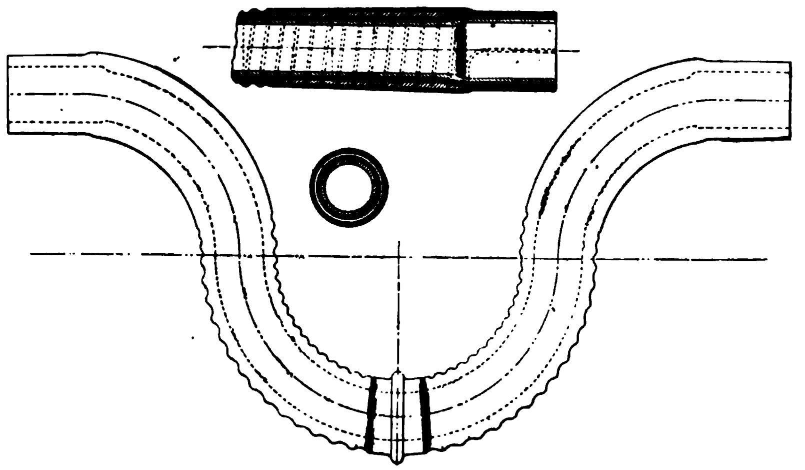
STEAM HOSE.

ONE of the practical difficulties encountered in heating cars with steam, and also in operating air brakes, is in getting hose for conducting the steam and compressed air from one car to the other, which will stand the service in which it is used. By the action of the steam especially a process of decomposition, or, rather, disintegration, takes place of the inner lining of the hose, which becomes softened and swells, and in time becomes exfoliated and is detached in shreds from the body of the hose, and the inner coating is thus ultimately destroyed. The hose, in fact, is subject to a process of deterioration, the effects of which are analogous to those resulting from inflammation of the bowels of men and other animals. The heat of the steam inflames or swells the inner lining of the hose, which diminishes its internal diameter; and later, as stated, shreds are detached which are carried into the pipes and to the valves and other attachments of the heating apparatus, thus clogging them and interfering with their action.

For a long time the belief was entertained by manufacturers of rubber hose that, in order to withstand the action of steam, it was necessary to compound the material of which it is made with large quantities of mineral substances. After much fruitless experiments it was discovered that this was a mistake. Experience in this direction was, in fact, somewhat like early experience with lubricants. Some of us can remember the time, before petroleum was discovered, when the mechanical world still enjoyed the benefits of that unrivaled lubricator, sperm oil. As the use of machinery was extended and increased the demand for the oil exceeded the supply, and it became too expensive for general use, and a substitute was sought in various directions. In this connection the writer recalls an early incident of his old boss, Ross Winans, who had the commendable characteristic that he would always give whoever came to see him a hearing if he deserved it. One day a dapper salesman came to the office to sell some new "blended" oils, and dilated at considerable length on the skill with which a variety of ingredients were compounded so as to produce the best results. Winans listened to him with great patience until he was through. "Well," he said, "what you say may all be so; but I have been using oil for more than forty years, and my experience is that there is nothing as good as pure sperm oil, and the more you mix the d—n stuff the worse it gets." The experience of some of the manufacturers of hose regarding india-rubber corresponds with that of Winans with reference to oil. The purer and the better the rubber, the less mixing is required to get good service out of it.

After the difficulties which have been described in the use of hose were encountered, it was attempted to retain its inside diameter and to obviate the effects of the swelling of its lining by inserting a coil of wire. This, however, resulted in little or no benefit, but was rather an injury, as the rubber would swell between the wire and would thus protrude inwardly, and the wire, by being heated and through mechanical action, chafed the rubber and detached it in shreds, so that the hose was ultimately destroyed much quicker than it was when wire was not used.

To carry our pathological simile a little further, it may be said of rubber hose, as of mankind, that a prime condition essential to longevity and health is to be properly born, and to have a good constitution to begin with. It is of the utmost importance that the original materials of which hose is constituted should be the best obtainable. The Peerless Rubber Manufacturing Company and others have spent much time and money in the investigation of the conditions essential to the longevity of rubber hose, and their conclusion is that, like animals, good stock is one and a very important safeguard against what may be called the intestinal diseases to which hose is liable, and that the best stock which can be used is fine Para rubber. With a good original constitution, the pathological parallel may be carried still further. It is found that for diseases of organisms thus constituted very simple remedies are required. Some years ago, while Mr. C. H. Dale, the General Manager of the Peerless Rubber Manufacturing Company, was in England, he discovered a very simple compound of which steam hose manufactured there is made, the basis, however, being fine Para rubber. While it is thought by good Americans, who are believers in the McKinley tariff, that foreign manufacturers are not the peers of the Peerless Rubber Company, it is true, nevertheless, that steam hose made of the compound discovered by Mr. Dale has given phenomenal results. While no pretense is made that there are any great secrets in the compounding of rubber for mechanical purposes, nevertheless the ingredient referred to is not generally known. It may be added, however, that it is a very simple remedy for the disorders of rubber hose, and it in no way interferes with the elasticity and flexibility of the gum with which it is compounded. In this respect it differs from all of the minerals heretofore employed in compounding. In order to get the best service it is necessary that the tube, friction, coating and jacket of the hose should all be made of the same fine material throughout. This necessarily increases the price of hose quite largely, and in these hard times it is not easy to convince buyers that the more expensive article is the cheapest in the end. It is asserted by the Peerless Rubber Manufacturing Company that all of the steam hose manufactured by them for car heating during the years 1893 and 1894, on this principle, gave very satisfactory results, wearing the entire season; and it is safe to say that 80 per cent. of it is still in good condition and fit for service for the season of 1894–95. They are prepared to supply hose for car heating with a guarantee of one season; and they claim that there is no question but that 90 per cent. of it will wear two seasons in service provided it is properly cared for and removed during the summer months, when steam



ARRANGEMENT OF STEAM HOSE FOR THE PENNSYLVANIA RAILROAD—HOSE PLACED HORIZONTALLY AS IN ENGRAVING, THUS DOING AWAY WITH SAG.

heat is not needed—that is, if it is taken off the cars and carefully stored until required in the fall.

The office of the Peerless Rubber Manufacturing Company is at No. 16 Warren Street, New York.

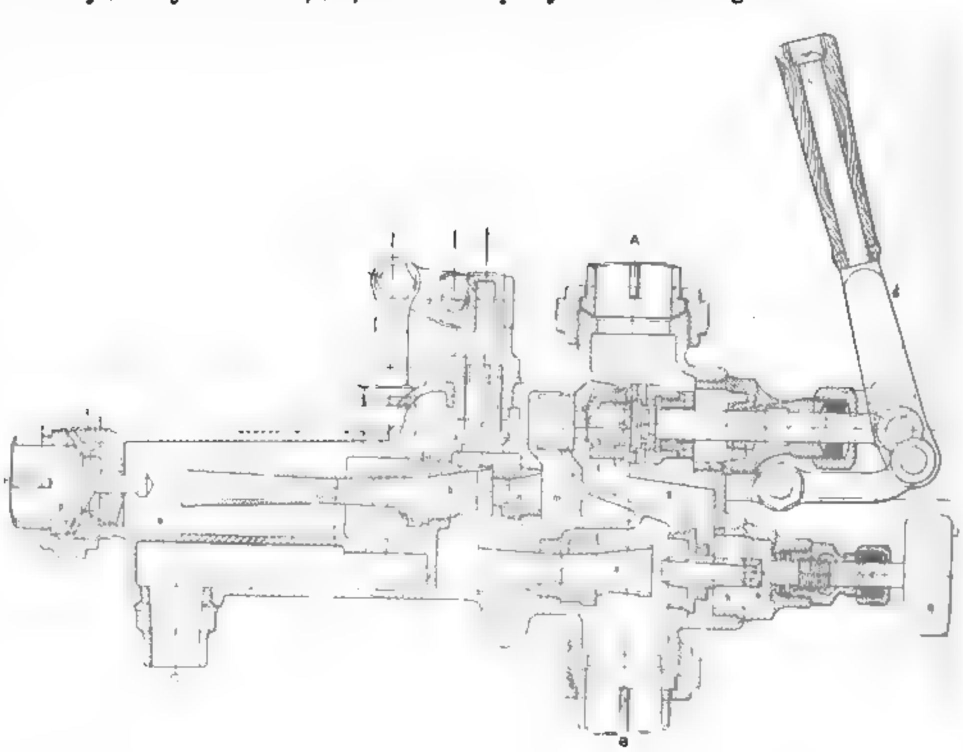
THE HANCOCK LOCOMOTIVE INSPIRATOR FOR 1894.

One of the most important elements in a good injector for locomotive service is its ability to operate efficiently through a wide range of steam pressures without adjustment. Many devices have been invented and placed upon the market to accomplish this end, but in nearly every case it has only been partially and very imperfectly effected by automatic devices of various kinds.

It has been found impossible to make a reliable jet apparatus that will work successfully through a range of 200 lbs. of steam pressure where one jet only is employed without using automatic devices for movement of its parts. The double-jet apparatus for use on locomotives as heretofore constructed, and to be operated with one movement, has been too complicated for practical use, the movement of its parts being confined to strictly time adjustment in their relations one to the other. This was a very objectionable feature in the old style of locomotive inspirator which has been wholly overcome in the improved locomotive inspirator of 1894. Such has been the press of business in other kindred lines that the Hancock Company have not been able until quite recently to devote the time and attention necessary to the development of a new and practically perfect locomotive inspirator.

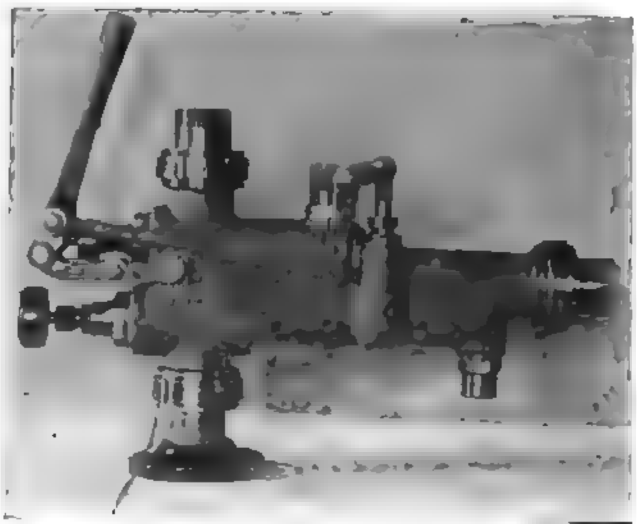
The 1894 instrument made by the Hancock Inspirator Company differs from the locomotive inspirators hitherto made by that company, in that it is very much simplified in its construction and operation; it is also much more efficient, and is especially constructed for the extreme service required by the locomotive. It operates with from 30 to 250 lbs. steam pressure without adjustment, and has a minimum capacity of 50 per cent. of its maximum. It will take water at a temperature of 120° F. at any steam pressure, and cannot be balked by a hot machine or suction caused by a leaky steam valve, or by blowing back into the tank, and it will deliver a constantly increasing supply of water with increasing steam pressures.

The new inspirator contains the special feature of the old style of a double set of tubes, one, *a*, for lifting and the other, *b*, for forcing; but these have been much improved and are now specially adapted for service on locomotives. Fig. 1 represents an external view of one of these instruments, and fig. 2 a longitudinal section. It will be noticed that they are shown in reversed positions, in order to show the different parts in each view. *A* is the steam supply pipe, *B* the water supply, *D* the feed pipe to boiler, and *C* the overflow.



LONGITUDINAL SECTION OF THE HANCOCK LOCOMOTIVE INSPIRATOR.

The action of the inspirator is controlled by a double steam valve peculiar to this form of inspirator, consisting of a valve, *e*, within another valve, *f*. The inner one, *e*, is opened by a slight movement of the lever *d*, which admits steam to the chamber *g* and to the lifter nozzle *h*, which starts the water flowing through the combining tube *a* into the chamber *i*. The water pressure in this chamber raises the intermediate valve *c* and allows the water to flow upward and then downward, and it escapes through the overflow valve *j* into the chamber *k* and out through the overflow pipe *C*. When a current of this kind is once established the lever *d* is drawn farther toward the right, which opens the main valve *f* and allows steam to flow through the opening at *l* into the chamber *m* and through the nozzle *n* into the tube *b*. This starts the forcing current of water through the tube *b* into the chamber *o*. The pressure in



THE HANCOCK LOCOMOTIVE INSPIRATOR.

o then closes the valve *c*, and a further movement of the lever *d* closes the overflow valve *j*. As soon as the pressure in *o* exceeds the boiler pressures, the check valve *p* is opened and the current of water flows through the feed pipe *D* into the boiler.

In order to regulate the amount of water fed to boiler a device is provided which consists of a valve, *s*, on the end of a spindle, *r*, which is operated by a handwheel, *q*. By this means the feed may be regulated from the maximum to the minimum capacity without touching the lever and without using a lazy-cock or regulating valve in the suction. This is claimed to be the first adaptation of this device for this purpose ever successfully applied to a jet apparatus.

The operation of the machines when put to work is as follows: A slight pull of the lever *d* opens the valve *e*, which admits steam through the main valve *f* and steam ports to the lifting side *g* and lifter steam nozzle *h*. The flow of steam

through the lifter tube *a* then produces a partial vacuum in the chamber *t* and suction pipe *B* which causes the water to flow upward through *B* and through the lifter tube *a* into the forcing chamber *i* and through the intermediate overflow valve *c*, which opens to the chamber containing the valve *j* and to the chamber *k* and overflow pipe *C*. The intermediate overflow valve *c* being located above the mouth of the forcing tube *b*, allows a quantity of water to flow through it and around the forcing nozzle *n*, which is sufficient to condense the steam which flows through it, and which at this period is admitted to it by a further movement of the lever *d* and valve *f*. This current of steam starts the jet of water through the tube *b* which raises the pressure in the delivery chamber *o* above that in the forcing chamber *i*, which causes the intermediate valve *c* to close, thus diverting all the water through the tube *b* and thence to the boiler, where the final overflow valve *j* is closed by the complete movement of the lever *d*. This operation, which takes many words to describe, is effected in practice in a few seconds.

These inspirators are made in four styles, to fit the connections of all standard injectors in common use. The Hancock Inspirator Company have the best possible facilities for producing these goods; they have a large factory and brass foundry filled with the latest improved machinery and employ the best engineering and mechanical talent to be obtained, thus insuring the highest possible efficiency and the greatest durability for their products. Their experience of nearly twenty years in the business of manufacturing jet apparatus and the reputation acquired is a guarantee of all the claims made by them.

For further information address the Hancock Inspirator Company, Boston, Mass.

PAGE WOVEN-WIRE FENCE COMPANY.

The effect of hard times on different people in business is very peculiar; some men seem to fall into a state of bewilderment, and rush to and fro without any definite purpose; others act upon the lawyer's maxim, "When you do not know what to do, do nothing." The conduct and conversation of some men during periods of depression would lead you to think that they never expected to do business again, but intended to quietly fold their hands and dry up. The latter they often do, while those who follow the advice of Livy, and "assume in adversity a countenance of prosperity," are the class of people who usually come out ahead. Now, whatever may be our opinions about the McKinley or the Gorman tariff, the prospects of business, or any other question, this much is true: that most of us must continue in business whether times are good or bad. Evidently the company whose name is at the head of this article are acting upon this assumption. They are making wire fencing, and mean that the whole world, but especially the railroad portion of it, shall know it. With this object in view, they took the trouble to be adequately represented at the recent Road Masters' Convention, which was held in New York. Mr. P. O. Fisher was on hand, prepared to show the merits of their products, and their facilities for fencing in anything, from a cemetery lot to a trans-continental railroad. They have also adopted the plan of publishing very attractive full-page advertisements in the railway papers, one of which appears on page xxxiv. of this issue. They have had photographs made showing specimens of their fence and its use along the lines of railroads. One of these is a view on the Lake Shore Railroad, and represents one of its fast mail trains running at full speed protected by this woven-wire fence. Another picture represents a scene along the line of the same road, which is again enclosed by the woven-wire barrier, but with a contemplative cow and three capricious calves in the foreground. Now, it is obvious from these illustrations that if the protective guardianship of the fence did not exist that the cow and the calves might wander on to the track where the train is, the result of which might be that the train and the cow might change places—that is, the cow would then be on the track dead and the train in the field. Just what does happen when roads are not fenced is shown by the following report of an occurrence on a Western railroad:

Schnieder's Falls, September 3, 1894.

To Mr. D. M. Yellek, The Honorable Road Master ——— Railroad:

Dear Sur: Your humble servant Andy Terry, Section Foreman at the Falls above knows but very little in regards to the killen of the bull on last Tuesday.

But howsuever what right had he there, when he lived two miles beyant the right of way, but nevertheless he came over, along in company with two of his friends, and, in the height of their jollity, they were cavorting the whole of the afternoon up and down the right of way, and presently along comes number 7 and hits the little bull a welt in the back and knocks him to the road below and breaks his bones to atoms—and the bull is dead. That is all I know in regards to the killen of the bull.

Your Humble Servant at the Falls above,

Andy Terry,

Section Foreman, Section 22.

P.S.—If there had been Woven-Wire Fence along the road the little bull would still be alive.

This company reports that they have sold 2,497¼ miles of fence in 8 months. At this rate, it will not take a great while to girdle the earth.

Recent Patents.

BROWN'S ELECTRIC RAILWAY CAR.

Mr. Charles Brown, of Basle, Switzerland, whose ingenious designs of locomotives and other machinery have given him a world-wide reputation, has turned his attention to electric cars, and has taken out a number of patents in this and in European countries. These, it is thought, will be worthy of the careful study of those of our readers who are interested in this class of machinery. The following is one of the most interesting of them:

"The main objects of my invention," he says in his specifications, "are to facilitate the running of street cars upon curves without unnecessary strain or wear upon the running gear, to increase the capacity and efficiency of self-propelling cars of this class, to facilitate access to and inspection of the motors, to protect the motors from mud, dust and moisture, etc.

"It consists essentially of mounting the car upon four independent trucks, each having two wheels in tandem and jointed connections with the car, whereby the wheels of each truck are permitted, independently of the wheels of the other trucks, to adapt themselves in position to curves and irregularities in the track, and of providing each truck with an independent motor.

"It consists also of locating the motor between the wheels of each truck with which it is connected by suitable gearing, and of enclosing the motor and the gearing connecting it with the truck wheels in a casing constituting a portion of the truck frame; and of certain other peculiarities of construction and arrangement hereinafter particularly described and pointed out in the claims.

"In the accompanying drawings like letters designate the same parts in the several figures.

"Fig. 1 represents a motor truck embodying my improvements, partially in side elevation and partially in vertical section cutting the horizontal axis of the truck transversely. Fig. 2 is a horizontal section of said truck in a plane cutting the axis of the truck wheels. Fig. 3 represents two connected trucks, one being shown in end elevation and the other in vertical cross section cutting the horizontal axis of the truck. Fig. 4 is a plan view of a pair of trucks. Fig. 5 is a side elevation of a car mounted upon my improved trucks. Figs. 6 and 7 are diagrams illustrating the manner in which the truck wheels of a car provided with my improvements adapt themselves to curves, a simple curve being shown in fig. 6 and a combined or reverse curve in fig. 7; and fig. 8 is a diagram illustrating the position of the wheels of an ordinary street car with reference to a curve of the same radius as those shown in figs. 6 and 7.

"Heretofore electric motors for street railway service have been applied to cars of a construction like or similar to that of horse cars, which are usually provided with two pairs of wheels rigidly mounted upon axles extending from one side of the car to the other, and rigidly held by their bearings at the same distance apart at both ends, so that in passing around curves, especially of the short radius usually found in street railways, the wheels on one side of the car are compelled to slip upon the rail. This difficulty of adaptation of the wheels to the curves is not serious in the use of horse cars which are made as light as possible and are guided upon the rails by the draft of the animals; but the difficulty is greatly increased and becomes serious by reason of the increased weight necessary in the adaptation of such cars to self-propulsion. The additional load thus placed upon the truck wheels renders their adaptation to curves by slipping on one side of the track much more difficult, and the strain and wear upon the running gears, motors, etc., correspondingly greater. The location of the motors, as heretofore, under the floors of the cars, renders access to the motors for the purpose of inspection and proper care difficult and inconvenient in many ways, and exposes them to dust, mud, etc. The gears are thus subjected to rapid wear, and the insulation of the conductors thus exposed rapidly deterio-

rates and tends to the destruction of the armatures. These difficulties it is the aim of my invention to overcome.

"Referring to figs. 1-4 inclusive of the drawings, A represents a truck frame formed in the middle between its wheels, F F, with a casing for the electric motor, of which B B are the field magnets, C the armature, and C^2 the collector or commutator. The frame A is pivoted at the middle of its upper side to a horizontal plate, A', so as to turn horizontally on a vertical

FIG. 1

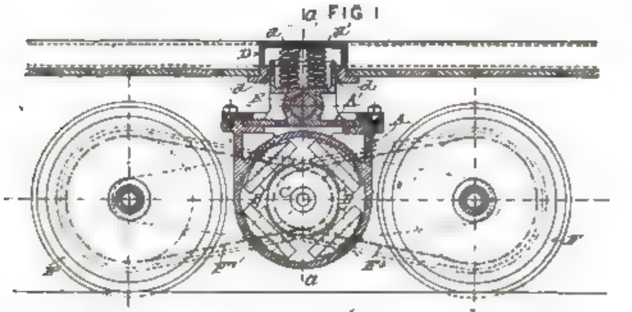


FIG. 2

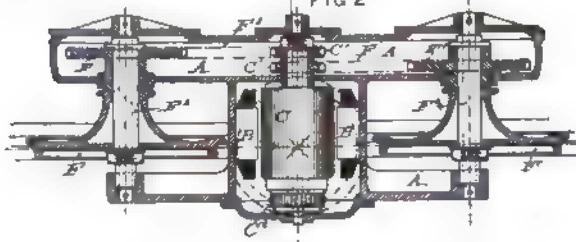


FIG. 3

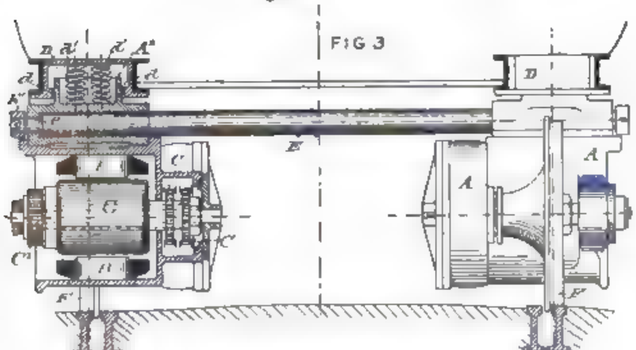
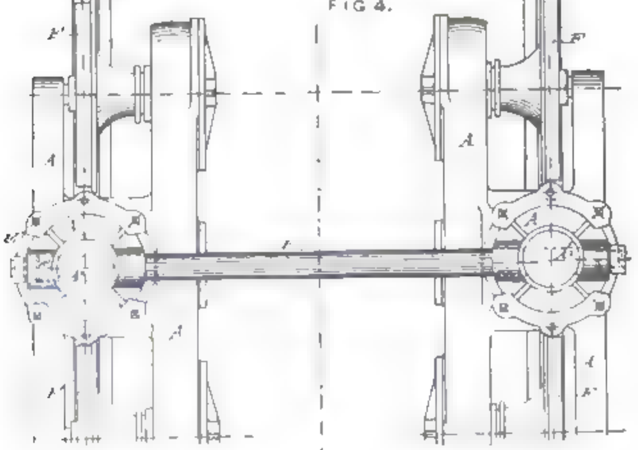


FIG. 4.



axis, a a, midway between the points of contact between the wheels F F and the rail upon which they run. The plate A' is formed on the upper side with a cup, A^2, which is loosely inserted in a cap, D, secured in the base of the car. Sufficient play is allowed between the cup A^2 and the inner face d of the cap D, to permit the plate A' to turn a limited distance upon the shaft E, upon the end of which it is mounted. The weight of the car body is carried by springs d' d' interposed between the cups A^2 and the caps D. The corresponding trucks on opposite sides of the car are connected by the shaft E and firmly held in their proper relative positions while they are each permitted to turn independently of the other upon said shaft, so as to allow the wheels on either side of the car to follow vertical variations in the rails. The vertical axes a a, on which the several trucks turn horizontally to permit the truck wheels to readily follow without binding curves in the track, intersect the axes of the shafts E, on which the trucks swing vertically to permit of the wheels following variations in the level of the rails. Each plate A' is formed on the upper side between it and the cup A^2 with a sleeve fitted to the end of the shaft E, upon which it is held by the shoulder e and collar E'. This sleeve is allowed a limited amount of endwise play upon the shaft E, as shown in fig. 3, to permit the trucks to adapt themselves to variations in the course of either rail. Upon the inner end of each armature shaft are mounted two separate sprocket wheels C' C' which are con-

FIG. 5

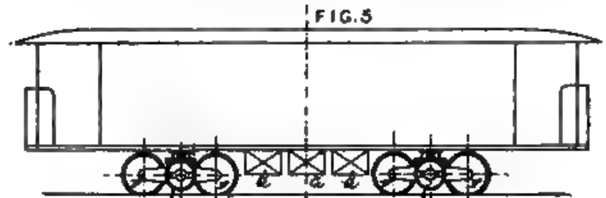
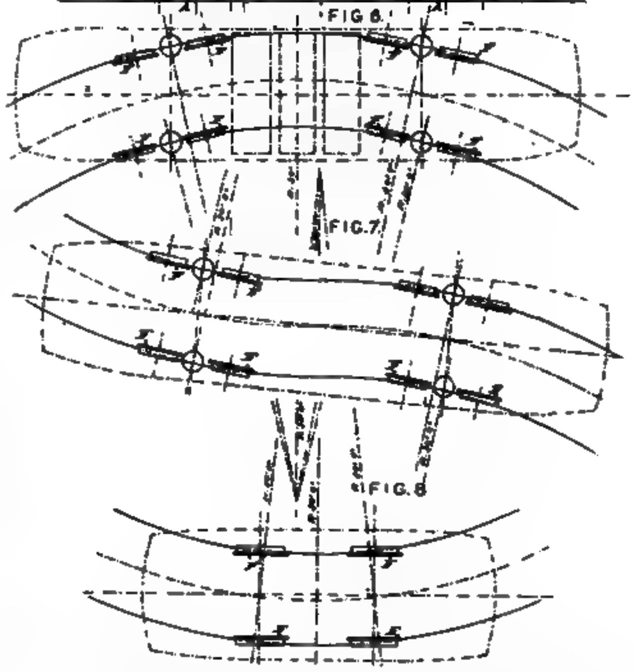


FIG. 6. FIG. 7. FIG. 8.



nected by and transmit their motion through chain belts to sprocket wheels F' F' connected with the truck wheels F F. The truck wheels F F and sprocket wheels F' F' are preferably mounted upon sleeves F^2, which turn upon shafts secured at the ends in frame A. The sprocket wheels C' C' and F' F' and the chain belts F^3 F^3 connecting them are enclosed in a case which constitutes a part of the frame A and protects them from mud, dust and moisture. It will be observed that the motors are located on the outer sides of the trucks, with their commutators or collectors C^2 outside, thus affording easy access thereto.

"Figs. 6 and 7, illustrating in diagram a car with four trucks, having jointed connections therewith in accordance with my invention, placed upon two curves of 30 ft. radius, one simple and the other compound or reverse, show in connection with fig. 8, which illustrates in diagram a car of the ordinary construction on a curve of the same radius, the great advantage of my improved system of trucks in comparison with the old. It will be observed also by reference to fig. 5 that my system permits of the employment of cars of greater capacity than those at present in use, and that the arrangement of the running gear affords ample space between the trucks for storage batteries G G, when they are employed to supply the motive power. This position of the batteries is for many obvious reasons preferable to that in which they are usually placed under the seats or upon the trucks."

The number of this patent is 494,819, and it is dated March 28, 1893.

AERONAUTICS.

UNDER this heading we shall hereafter publish all matter relating to the interesting subject of Aerial Navigation, a branch of engineering which is rapidly increasing in general interest. Mr. O. Chanute, C.E., of Chicago, has consented to act as Associate Editor for this department, and will be a frequent contributor to it.

Readers of this department are requested to send the names and addresses of persons interested in the subject of Aeronautics to the publisher of THE AMERICAN JOURNAL.

A WAR BALLOON STRUCK BY LIGHTNING.

(From the London *Times* of September 6.)

AN extraordinary accident, happily not attended with fatal results, occurred yesterday afternoon about four o'clock at the School of Military Ballooning, at Aldershot. A new balloon, larger than any of its predecessors, was to have been "christened" by the Duchess of Connaught. This balloon, to be named after her royal Highness, had been inflated during the morning, and stood ready, gaily decked with bunting. It had been arranged that the Duchess was to cut the ropes retaining the balloon, and that Lieutenant Baden-Powell, of the Scots Guards, and two sergeants of Royal Engineers were to make a free ascent. The *Flo*, the smallest military balloon, containing 4,700 cub. ft. of gas, was also inflated, and bore a large royal standard. As soon as the royal party, consisting of the Duke and Duchess of Connaught and staff, arrived on the ground, this smaller balloon was sent up captive as a royal salute. Lieutenant Blakeney had intended to ascend in it, and had actually got into the car; but as at this moment some sudden strong gusts of wind arose and large drops of rain began to fall, it was decided to send up the balloon without any one in the car. The *Flo* then made a beautiful ascent with its large standard just as the royal party entered the grounds, where they were received by Colonel Sir A. Mackworth, Colonel Templer, Lieutenant Baden-Powell and other officers.

As the rain began to descend more heavily the party repaired to the storehouse, and very shortly afterward the accident happened. The balloon was held by a wire cable about 200 ft. long, fixed to the drum on the balloon wagon. Suddenly it was seen to be struck by lightning, a blue light surrounding the lower part of the balloon for some seconds, and then a flame shot up from the ignited gas, and the balloon fell precipitately to the earth amid a loud peal of thunder. Loud shouts from the sappers forming the detachment at the wagon attracted attention, when it was seen that three of them were rolling on the ground apparently in intense pain. It seems that the men were about to haul the balloon down by winding in the winch, the handles of which are covered with brass, when suddenly all who had hold of the winch were struck down. Every assistance was immediately rendered to the injured men, the Duke of Connaught himself running to the spot and covering one of the men with his own great coat. It was soon seen that, though evidently in great agony, none of the sufferers were very seriously injured. One, a bugler, had the inside of his hand rather badly burned; but the worst case of the three showed no external signs of injury. The car of the balloon, which contained a heavy bag of ballast, fortunately fell without doing any damage. On examination it was found that all the upper part had been burned away, though the metal valve was almost uninjured. Had any one been in the car, even if he had escaped uninjured from the electric shock, he would have had a terrible fall.

The thunder-storm did not last long, but it was deemed advisable to postpone any further experiments. About an hour after the occurrence two of the injured men were taken by ambulance to the hospital, still being apparently in great pain. No similar accident has ever happened before to an English war balloon, though a somewhat similar incident occurred some years ago in the case of a military balloon in Italy.

A subsequent report said that the three men who were injured were progressing favorably, and no serious result or disablement was anticipated.

NAVIGABLE BALLOON AT THE ANTWERP EXHIBITION.

THE chief point of difference between this balloon and all those which have preceded it is in the method of applying the motive force. Instead of turning the propeller by hand, or by steam or other power generated in the car, it is to be worked by electricity, conveyed to the balloon through a flexible cable from dynamos at a central station. Practically, the principle is the same as with the electric tramways, except that the balloon will resemble a tramcar without brakes; but it will be subjected to another difficulty from which tramcars are exempt: it will not always be easy to maintain electric connection, while it will be extremely difficult to re-establish it if accidentally interrupted while the balloon is in the air.

The electricity is generated by a pair of 200-H.P. gas-engines, made by Messrs. Fielding & Platt, driving dynamos which, with switches and other electric fittings, have been supplied by the Oerlikon Works. To obtain gas for these engines, as well as for inflating the balloon, a complete plant has been erected by the Dowson Economic Gas & Power Company, of Westminster.

It was at first intended that the balloon should travel from the Exhibition to the Bourse, on the roof of which there was

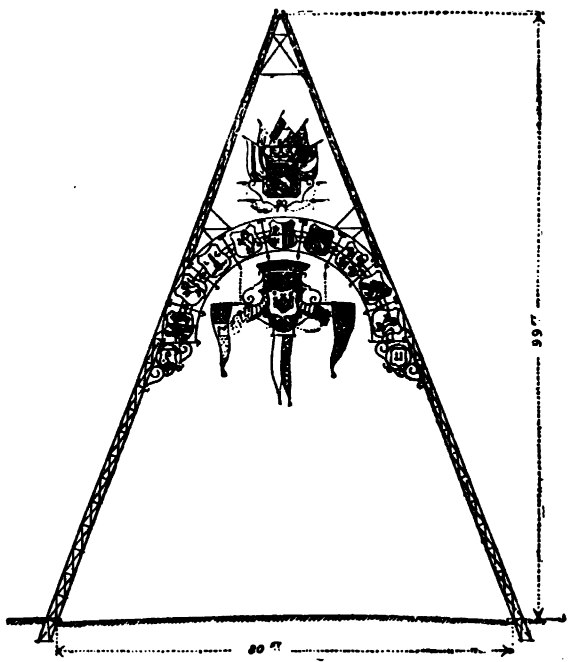


Fig. 2.

TROLLEY POLE FOR NAVIGABLE BALLOON.

to be a station; it was also proposed in some instances to carry the cables on the tops of existing telegraph poles; but the postal authorities not only refused to sanction the use of the poles, but objected to the cables crossing any lines of wire, so a shorter and straighter route had to be selected. It was then decided—see dotted line on fig. 1—to go straight down the Rue Nationale, which enters the Place Verte on the opposite side to the Cathedral, to turn the balloon above the Place Verte, and to return by the same route to the starting-point. Six steel lattice trestles, 100 ft. high, were erected last May to carry the cables. They span the road from pavement to pavement, having an average width of 80 ft. Fig. 2 shows the trestle at the end of the Rue Nationale furthest from the Exhibition; the others are less ornate. They are all made of 3½ in. by 3½ in. by ⅜ in. angles, with 3 in. by ⅜ in. flat plates; the legs being 20 in. square at the bottom, and 12 in. square at the top. They were each put up in one piece, and the method of erection was primitive. The apparatus consisted of two pairs of sheer-legs let into timber sills. Between the tops of the legs were inserted derricks, reaching a few feet down, and secured by planks bolted across; between the legs at the bottom were wooden windlasses with four square holes at each side. In these holes workmen had to insert wooden capstan bars, climb up, and by means of their own weight hanging on the bars, turn the windlasses. The arrangement

of the top of the trestles will be seen more clearly from the drawing of the trolley, figs. 4 and 5. The current is conveyed from the generating station by three parallel cables of galvanized steel wire 1 in. in diameter. These, which are each 1,400 yds. long, are in one piece, and are made by Messrs. Bullivant & Co., of Mark Lane.

The general arrangement of the balloon is shown on fig. 3. It is made of linen, specially woven for the purpose, and coated with three layers of varnish. Instead of a net, an outer envelope of the same linen is used; the weight of the double covering being about 4 tons. It is spindle shaped, 57 ft. in of *papier-maché*, and although it is capable of transmitting 125 H.P., its weight is a little under a ton. The screw has four blades, its diameter is 26 ft., and M. Leon Champy, the inventor, has calculated that in calm air the balloon will be able to travel 25 miles an hour, and that consequently he will have sufficient force at his command to be able to drive the balloon against a strong wind. The connection between the three cables and the dynamo in the car is made by an elastic cable, which passing over a drum with an automatic coiling arrangement in the car, terminates in the trolley shown on fig. 4. The captain's station is in the cylindrical portion of

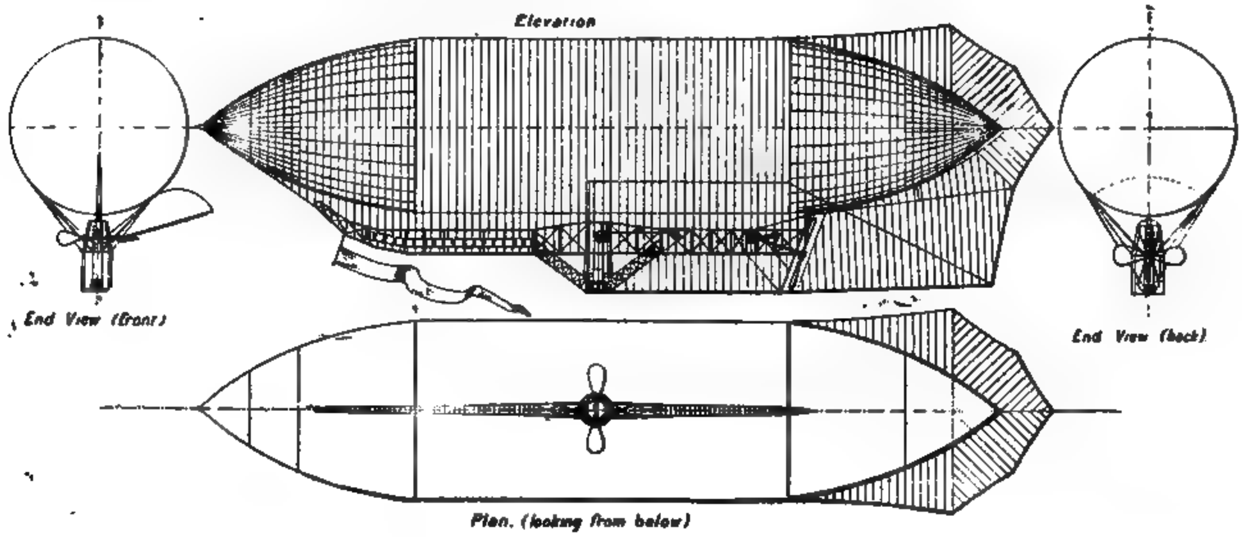
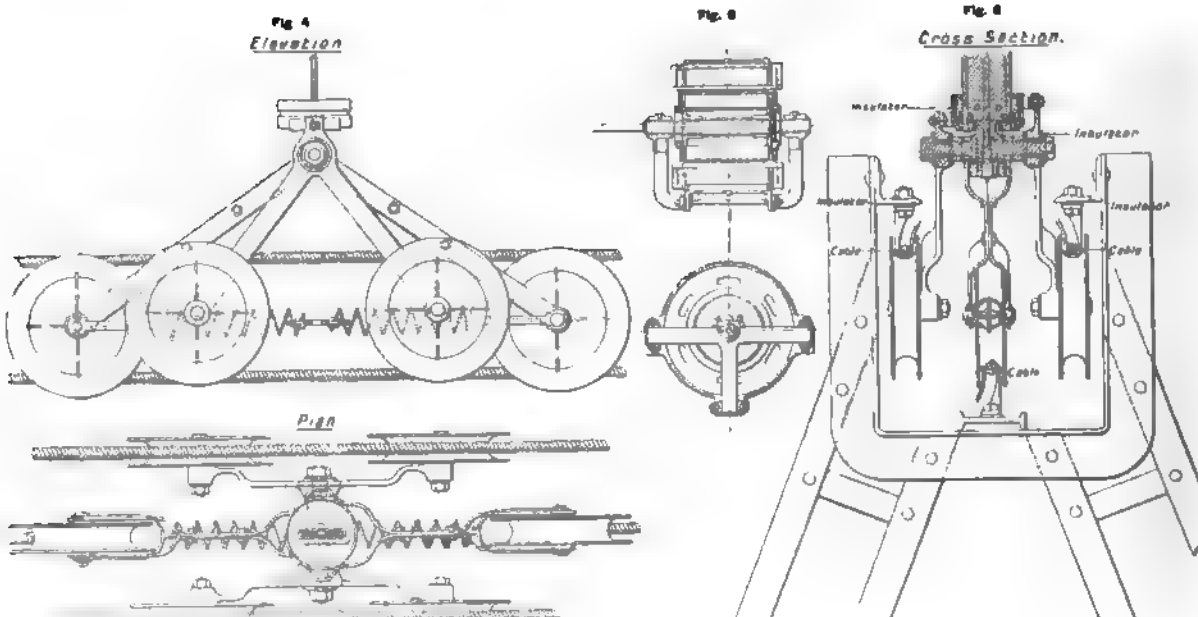


Fig. 3

THE NAVIGABLE BALLOON AT THE ANTWERP EXHIBITION



DETAILS OF NAVIGABLE BALLOON AT THE ANTWERP EXHIBITION.

diameter, and from the foremost point to the end of the rudder measures 284 ft. Its cubic capacity is 500,000 ft. A valve at the top for letting out the gas has a *papier-maché* frame. It is 4 ft. in diameter, and weighs only 70 lbs. The car is made of steel gas piping, covered with wickerwork, and, as may be seen by the illustration, it is of very peculiar shape. The center is cylindrical, 8 ft. in diameter, and reaches down to much lower than the front and back portions. Of these the front is intended for passengers; it is entirely closed, but with windows. The back is for the crew, and contains the dynamo for transmitting the power to the screw; it is shown in fig. 6, and is also from the Oerlikon Works. Its casing is the car, and from it he will be able to increase or diminish the speed of the balloon, as well as to raise, lower, and steer it.

Antwerp is not the most suitable locality that could be found for aeronautical experiments, as the sudden gusts of wind from across the Scheldt will make steering more difficult than it would be in a steady breeze. It is also to be regretted that a course could not be chosen in which it was not necessary to make such a sudden turn of the balloon, as will be required at the Place Verte, and that the experiment was not first tried with a smaller balloon, so that the resistance to side winds might be less. Still, we hope to be able to report in a few weeks that M. Champy has had a satisfactory trial run,

for it is certain that if aerial locomotion succeeds at Antwerp, it will soon be tried elsewhere over a longer course.—*The Engineer.*

THE DEVELOPMENT OF AERIAL NAVIGATION.*

By Hiram S. Maxim.

In 1890 I tried a series of experiments with a view of ascertaining how much power was required to perform artificial flight. An account of these experiments written by myself, and entitled "Aerial Navigation—the Power Required," appeared in the *Century Magazine* of October, 1891. The apparatus used in these experiments was constructed with great care and was provided with all sorts of delicate instruments which enable me to ascertain definitely the exact power required for performing artificial flight on the aeroplane system driven by screw propellers.

As is well known, when one flies a kite the cord holds the kite against the wind. The wind passing on the under side of the kite strikes it at an angle and raises the kite into the air. If the wind be blowing at a high velocity—say 35 miles an hour—the kite will lift from 1 lb. to 5 lbs. per square foot, according to the angle at which it is held in the air. If the angle be slight, the amount of strain on the cord necessary to hold it against the wind will be found considerably less than the weight of the kite and the load which it is able to lift, particularly so if the cord pulls in a horizontal direction instead of at an angle. It is also well known that if a kite be propelled in a calm through the air, say at the rate of 35 miles an hour, the effect is exactly the same. Suppose now, instead of the cord for holding the kite against the wind or for propelling it against still air, that a screw propeller should be attached to the kite and that it should be driven by some motor. If the screw propeller could be made to give a push equal to the pull of the kite, and if the machinery for driving it should be no greater than the weight that the kite would be able to carry, we should have a veritable flying machine.

In my first experiments to ascertain the power required, the aeroplanes employed were formed of thin pieces of wood, the under side being slightly concave and the top side slightly convex. These aeroplanes I was able to propel round a circle 200 ft. in circumference at a speed say from 20 to 90 miles an hour, and with the planes at any desired angles. When the inclination was 1 in 14 it was found that a thrust of 5 lbs. on the screw would lift 14 times 5 lbs., or 70 lbs., on the plane. It was also found in these experiments with a plane set at an angle of 1 in 14, that as much as 133 lbs. could be carried with the expenditure of 1 H.P. These experiments, which were very full and complete, and which embraced many different kinds of screw propellers and aeroplanes, demonstrated that a two bladed wooden propeller with a pitch slightly greater than the diameter, was the most advantageous, the propelling power being very great and the loss by slip comparatively small. Narrow aeroplanes slightly concave on the under side, set at a slight angle and driven at a high speed, were found to be the most efficient, and any distortion or bagging of the aeroplane increased enormously the power required.

Having ascertained experimentally the power required, I at once commenced experiments with a view of developing the necessary motive power. Everything considered, I believe that steam power would be more efficient for the weight than any other source of energy. First I made two pairs of compound engines, the high-pressure cylinders being 5 in. in diameter, the low-pressure cylinders 8 in. in diameter, and all having a stroke of 12 in In order to make the engines as light as possible, the cylinders were made about $\frac{3}{32}$ in. thick, of a high grade of fluid compressed steel. The valve chambers and passageways were made of seamless steel tubes, the whole being neatly riveted together and brazed with silver solder.

The crank shaft was of comparatively large diameter, but hollow and of highly tempered steel. All the piston and valve rods, and also the framework of the engine, were constructed of hard and thin tubular steel. When the engines were finished they were found to weigh 300 lbs. the pair, or 600 lbs. in all. The high-pressure cylinder was made with a considerable amount of clearance, so as to avoid danger if water should go over with the steam, and the piston valves were made to cut off at $\frac{1}{2}$ stroke, while steam was cut off in the low-pressure cylinder at $\frac{5}{8}$ stroke. Believing that on some occasions I might require to put on a tremendous spurt, I placed a kind of an injector valve between the high-pressure steam directly from the boiler and the exhaust from the high-pressure cylinder. This injector was provided with a spring value regulated in such a manner that in case the boiler pressure should rise above 300 lbs. to the square inch, instead of blowing off steam at the safety-valve, the steam would open a passage directly into the low-pressure cylinder, and, as the passageway was annular and arranged to be more or less large in proportion to the steam passing, the steam in falling from a high to a comparatively low pressure was made to do a certain amount of work on the exhaust steam, thus increasing the pressure in the low-pressure cylinder without greatly increasing the back pressure in the high-pressure cylinder. This is a new feature, which, I think, has never been used on a compound engine before.

The first steam generator was constructed of a very large number of small and thin tubes. It was constructed so as to admit water at one end of the series and to draw steam from the other end, and to so regulate the fire as to convert about 90 per cent. of the passing water into steam. This boiler was of great lightness, not weighing without its casing more than 300 lbs., and was heated by 50 sq. ft. of flame; but it was found impossible to so regulate the fire and the water supply as to have comparatively dry steam without destroying some of the tubes. If twice as much water as is evaporated was pumped through the boiler, it stood the heat fairly well; but upon any attempt being made to reduce the quantity of water, some of the small tubes, which were of copper, would invariably burst. This boiler was, however, remarkable because steam could be raised in about 10 seconds, and on some occasions an ample supply of steam was made to run the engines up to 300 H.P.

The first boiler having failed, I at once determined to make a boiler on a new plan, but before doing so I tried a series of experiments so as to be sure of my ground in my second attempt. I obtained a quantity of copper tubes $\frac{3}{8}$ in. in diameter, $\frac{1}{50}$ in. thick and 8 ft long. Four of these were connected together and provided with a forced circulation; they were then placed in a white-hot furnace and made to evaporate at the rate of 26¼ lbs. of water per square foot per hour at a pressure of 400 lbs. to the square inch. Having stood this test, a single tube was placed in a white-hot furnace similarly connected, with a view of finding the bursting pressure under steam. It exploded at 1,650 lbs. to the square foot. Some hundreds of tubes were then tested with one ton per square inch pressure of cold kerosene oil, and as none of them showed any signs of leaking, the new boiler was constructed of these tubes. The general form was somewhat similar to the water-tube boilers employed on torpedo-boats in France and England, except that the tubes were relatively much longer for their diameter and had twice as many bends in them, and to insure circulation a down-take for the water outside the fire-box was provided. The feed-water in coming from the pump passed through a very elaborate network of fine copper tubes immediately over the boiler and at a pressure 80 lbs. greater than the boiler pressure. A spring valve nozzle was interposed between the feed-water heater and the down-take for the water in such a manner that the escaping force of the water operated powerfully on the surrounding water in the down-take, and thus secured a very rapid circulation through the long and slender tubes which formed the main heating surface of the boiler. This new boiler has proved itself to be very efficient indeed; the network of very fine tubes which forms the feed-water heater greatly reduces the temperature of the escaping products of combustion, so that the heating of the top of the casing of the boiler is never great enough to burn paint off the smokestack. The new boiler was first tested to 410 lbs. cold water pressure, and then to 325 lbs. steam pressure. Having completed the new boiler it was placed in position, and experiments commenced with petroleum burners. The new boiler had a very much reduced fire-box. Whereas the first experimental boiler had what might be called 40 sq. ft. of grate surface, the new boiler had only 28 sq. ft. In ordinary boilers heated by petroleum the furnace is supplied with one or two very powerful jets, burning against brickwork or fire clay. This, of course, would be quite out of the question with a flying-machine boiler. Moreover, with such a light boiler it was not advisable to have a very intense flame; what was necessary, of course, was a very large and even flame, so as to heat all tubes equally. The first burners experimented with worked all right for about 100 H.P.; but whenever any attempt was made to increase the flame, great unevenness in the flame occurred, some parts of the fire-box being filled with flame, while other parts had no flame at all. After much experimenting I finally decided to use naphtha, 72° Beaumé.

The naphtha was pumped into a small and exceedingly light vertical boiler, where it was heated with a flame generated from part of its own contents arranged in such a manner that whenever the pressure of the gas or the vapors of petroleum exceed-

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ed 50 lbs. to the square inch the flame was automatically shut off, while if the pressure fell slightly below this the flame was turned on so that, no matter how much gas or vapor was drawn from the boiler, the pressure remained constant. This small boiler was suspended by springs in such a manner that whenever the weight of the contents exceeded 40 lbs., it moved the boiler slightly downward, which operated upon an escapement on the pumping mechanism in such a manner that when the weight was greater than 40 lbs. the stroke of the pump was diminished; while if the weight was less than 40 lbs. the stroke was increased. This apparatus was found to work admirably; and no matter how much or how little gas was drawn from the generator, the weight of liquid and pressure of gas always remained constant. The vapor was led from the generator through a pipe in the furnace, where it became superheated, and then was blown through a species of an injector into the furnace, sucking a large quantity of air through a suitable opening, which could be regulated so as to make the gas of any desired density.

Many burners were experimented with, the first one having as many as 14,000 jets; the one finally adopted had 7,650 burners, and was so arranged that any amount of gas might be consumed without any unevenness, smoking, or blowing. Having perfected my boiler, my gas generator, and my pumping apparatus, so that all worked smoothly and automatically, I attached a pair of very large and carefully made linen-covered wooden screws to the screw shafts. These screws were 17 ft. 10 in. in diameter, and had a slightly increasing pitch, the mean pitch being rather more than 16 ft. It will be understood that the boiler was placed upon a platform about 8 ft. wide and 40 ft. long; that the engines and screws were held by strong tubular brackets above the rear end of this platform, and that the whole was mounted on four steel wheels; that there were springs interposed between the axletrees of these wheels and the platform; and also that there were vertical tubes and wires attached to the platform which held the large aeroplane, which is about 30 ft. × 50 ft., in position.

At the same time that the experiments were going on with the burners and boilers, a railway track 1,800 ft. long was being laid, and the framework of the machine was being brought to a state of completion. Upon moving the machine on to the track, tying it up and attaching it to a dynamometer, I filled the boiler with water, got up steam with a slow fire in about 3 minutes and started my engines, when everything was found to run very smoothly indeed.

With 200 lbs. pressure to the square inch, the thrust of the screws was about 1,400 lbs., but by running the pressure up to 325 lbs. to the square inch, the thrust of the screws went up in the first instance to 1,160 lbs., and finally in a later trial to 1,260 lbs. These experiments should have been tried on a railway track of considerable length, but as I was only able to get a clear track of 1,800 ft., it was found necessary to provide suitable mechanism in order to bring the machine to a state of rest without injury. The best apparatus for this purpose was found to be a series of very strong ropes stretched across the track, each end of the rope being attached to the capstan, and each capstan being provided with a strong plank which acted as a fan. This apparatus stopped the machine without the least shock.

The first experiments were tried without any cloth on the framework, and it was found that when the machine was liberated it started off very quickly, in fact so quickly that it nearly threw down any one who was standing upon it.

After having tried several experiments with the naked framework, the main aeroplane was put in position and a few runs made, but the bagging and distortion of the cloth was such that it required the full power of the engines with a screw thrust of 2,000 lbs. to drive the machine at the rate of 25 miles an hour, and the lift did not exceed the thrust of the screws. This aeroplane was then removed and a new one substituted. The second aeroplane was made of two thicknesses of cloth completely inclosing the framework and arranged in such a manner that a portion of the air could pass through the lower side and produce a slight pressure of air between the two thicknesses. The top side would therefore bag upward and take the lift, while the bottom side having practically the same pressure on both sides would remain perfectly straight and would not be distorted in the least by running.

The first experiments with this new aeroplane were tried with a screw thrust of about 800 lbs., and the lifting power was actually more than with the old aeroplane with 2,000 lbs. thrust. Upon increasing the screw thrust to 1,200 lbs., the lift of the aeroplane was greatly increased, so that the front wheels barely touched the track. I saw that it would not do to run at a greater speed, so I put on some very heavy wheels, weighing 600 lbs. each, which I believed would keep the machine on the track, even if I ran the engines at full speed. I then greatly increased the thrust of the screw, and, finally, ran over the track with a screw thrust of about 1,500 lbs.; but, unfortunately, I met a slight gust of wind coming from an opposite direction, which lifted the front end of the machine, wheels and all, completely off the track.

This accident, although it did not injure the machinery in the least, showed the weak points in the platform and framework of the machine, and I determined to rebuild it completely and to discard the heavy wheels. While the machine was being rebuilt I put up on each side of the railway track, and about 10 ft. from the rails a second track (inverted) of heavy wooden joists, and provided the new machine with four additional wheels placed at such a height that when the machine was raised 1 in. clear from the lower railway track, these new wheels on outriggers would engage the lower side of the joists and thus keep the machine from going off the track. This arrangement has been found to work exceedingly well. It is certainly a great improvement on the old heavy wheels, which not only made the starting and stopping of the machine more difficult, but also failed in keeping it on the track. The upper rail enabled me to make a large number of runs and to note carefully with suitable instruments exactly how much the machine lifted at various speeds. Having finished a series of experiments and ascertained the lift of the main aeroplane with a great degree of nicety, I placed the fore and aft rudders, which were intended to steer the machine in a vertical direction, in position, and made several runs with these rudders at different angles. They were found to work exceedingly well, and I was able to depress or elevate either end at will. The machine had been provided with 10 auxiliary aeroplanes, which consisted of balloon cloth stretched very tightly on frames, and which could be placed one above the other (superposed) on each side of the machine if required. Of these 10 aeroplanes only four were actually used, the lower ones which extended on either side of the machine 30 ft., and the upper ones which extend 27 ft. each side of the main aeroplane and which bring up the total width of the machine to 104 ft. These long and comparatively narrow planes were found, as expected, to be more efficient foot for foot than the main aeroplane.

The first trials with these planes in position were made on July 31 last on a perfectly calm day, and three runs were made, the first with 150 lbs. pressure of steam per square inch. The speed was 26 miles an hour and the maximum lift 2,750 lbs. The second run was made with 240 lbs. of steam. The speed recorder on this occasion failed to work, but it is probable that the speed was 35 miles an hour. The maximum lift was 4,700 lbs. Then everything was made ready for a final test with practically the full power of the engines. Careful observers were stationed on each side of the track, and I took two men with me on the machine, the duty of one being to observe the pressure gauges, and that of the other to observe and note the action of the wheels on the upper track. The machine was tied up to a dynamometer, the engines started at a boiler pressure of 310 lbs. and with a screw thrust of a little more than 2,100 lbs. Upon liberating the machine it darted forward with great rapidity while the screws rotated at a terrific rate. I turned on slightly more gas, and the pressure almost instantly rose to 320 lbs. to the square inch and blew off at the safety-valve at that pressure. After running a few hundred feet, the machine was completely lifted off the lower rails, and all four of the upper wheels were engaged on the upper or safety rail. After running a few hundred feet in this position, the speed of the machine greatly increased and the lift became so great that the rear axletrees holding the machine down were doubled up and the wheels broken off. The machine then became liberated, the front end being held down only on one side. This swayed the machine to one side, brought it violently against the upper rails, and stopped it in the air, the lift breaking the rails and moving them outward about 10 ft. Steam was, however, shut off before the machine stopped. The machine then fell to the earth, imbedding the wheels in the turf, showing that it had been stopped in the air, had come directly down, and had not moved after it touched the ground. Had this last experiment been made with a view to free flight, and had the upper rail been removed or the wheels taken off, the machine would certainly have mounted in the air and have traveled a long distance if necessary. As it was, the lift certainly exceeded the full weight of the machine, the water, the fuel, and the men by 2,000 lbs., and was far beyond the registering limit of the dynagraphs, the pencil being drawn completely across the paper on the recording cylinders.

These experiments at Baldwyn's Park are the first that have ever been attempted with the machine running in a straight line. The prime object of these experiments has been to demonstrate whether it is possible or not for a large machine to

be constructed sufficiently light, powerful, and efficient to actually lift into the air its own weight and the weight of one or more men. All other flying machines which have ever been built in the world have persistently stuck to the earth, and this is the first occasion in which a machine has ever been made to raise itself clear of the earth. It has been admitted by all scientists that as soon as a machine could be made with motors powerful enough to actually lift it in the air, aerial navigation would become practical. I have demonstrated that a good and reliable motor can be made with sufficient power for its weight to drive a flying machine, that a very heavy flying machine may be made to raise itself in the air with water, fuel, and three men on board; and that it may lift, in addition to all this, 2,000 lbs. It now only remains to continue the experiments with a view of learning the art of manœuvring the machine; and for this purpose it will be necessary for me to seek some large, open, and level plain, and to commence by making flights so near to the ground that any mistake in the steering cannot result in a serious mishap.

MR. MAXIM'S FLYING MACHINE.

Sir Robert Rawlinson "went" for Mr. Maxim after the following fashion in the London *Times* a short while ago. In a letter to that paper the distinguished correspondent said:

"Up to this point the Maxim flying machine is only a wrong-headed, stupid waste of money on an apparatus so far innocent of murder. The notice in the *Times* may, however, lead to a catastrophe. I have witnessed one such in London, and have no desire to see another. Some years ago a Belgian brought over to the Cremorne Gardens a flying machine to be raised into the air by a gas-inflated balloon. This I saw go up, and I also saw it come down with a crash into a street in Brompton. The inventor was alone beneath his machine, and, in the presence of his wife, was killed. It was no great stretch of prophecy to predict this result, neither will it be to predict a similar result to Mr. Maxim if ever he ventures to soar, and does soar, a few yards above his tramway, as there must and will be then a downward crash of frame, sails, boiler and man. The albatross and large gulls of the tropics are, in their flight, the most graceful sights in creation: but in storms they are subject to having broken wings. And how is man to build up a machine to fly by mechanical power like an albatross or gull? The machine noticed in the *Times* this day is, however, evidently a long way from flying."

To this Mr. Maxim replied:

"Similar experiments [to those referred to above] have been made a great many times, but generally the experimenter mounts some high building, jumps off, comes to the ground, and breaks a limb or his neck.

"In my case, however, I prefer to experiment with a machine on the ground. Then if the machine has not sufficient energy in it to sustain itself in the air it certainly will never have an opportunity of falling, because it will never rise; consequently I am quite safe in this respect. If I had taken the first machine which I ever made up in a balloon and dropped it, it would certainly have come to the earth with something like a crash; not, however, severe enough to have killed any one, but still it would have been quite unmanageable in the air. But instead of doing this I kept on improving my machine, increasing the efficiency of my motors and screws, till I actually got a machine which would raise itself off the track on which the experiments were being made.

"I am not experimenting with a view to evolve a machine for carrying passengers and freight, as I think it will be a very long time before a flying machine can be profitably employed for the purpose of carrying coals from Newcastle.

"I am quite free to admit that the navigation of the air is beset with a great many dangers; it is also very dangerous to make high explosives or fire large guns, but it is infinitely more dangerous to be within the range of an enemy's guns. What I propose to do is to enable one to assail an enemy from a distance greater than the enemy will be able to strike back with the most powerful gun in existence. So I think it would be quite as safe for combatants to employ my means of assault as to employ the present means, which necessitate their approaching nearer to the enemy and having to receive its fire.

"I do not know that any one has ever invented a system of warfare which is perfectly safe. It is known now to be possible to make a machine that will actually fly at a very high velocity; so nothing remains to be done except to learn how to manœuvre it. In view of the decided advantage which a flying machine would give its possessor over an enemy, I do not think that in case of war European nations would hesitate to employ them even if one-half of the men navigating them were killed. At the present time no difficulty is ever found in getting volunteers to make a torpedo-boat attack upon a man-of-war—something which is infinitely more dangerous than navigating a flying machine would be, as the latter might be painted black and make its attack at night or in a fog, when it would be quite impossible for the enemy to strike back.

"War, at best, is a dangerous game, and those entering upon it are playing with dangerous instruments, whether they are guns, dynamite, or flying machines. I do not hesitate to say that the European nation which first takes advantage of this new engine of destruction will be able to modify the map of Europe according to its own ideas. Who shall it be?"

RECENT AERONAUTICAL PUBLICATIONS.

We shall hereafter publish brief references to such publications and articles concerning Aeronautics as seem to possess interest for our readers.

Zeitschrift für Luftschiffahrt und Physic der Atmosphere, Berlin, Germany; monthly; specially devoted to Aeronautics.

L'Aéronaute, Paris, France, 91 Rue d'Amsterdam; 9 francs a year to United States; monthly; specially devoted to Aeronautics.

L'Aérophile, Paris, France, 113 Boulevard Sébastopol; 12 francs a year to United States; monthly; specially devoted to Aeronautics.

Practical Flight. C. E. Duryea. *Cassier's Magazine*, September, 1894. Gives an account of some partial successes, and indicates the prospects and uses of a successful machine.

The Empire of the Air. L. P. Mouillard. Smithsonian Report 1892 (issued 1894). A translation and synopsis of a remarkable book upon the flight of birds, published in 1881.

Man Flight near at Hand. J. R. Zuberbühler. Boston *Evening Transcript*, August 11, 1894. Discusses the subject generally, and advances some personal views of the writer.

Scientific Problems of the Future. Lieutenant-Colonel H. Elsdale. *Contemporary Review*, March, 1894. Discusses the conquest of the air as the first of four important problems.

Gliding Flight. L. P. Mouillard. *Cosmopolitan Magazine*, February, 1894. A popular account of the further observations and meditations of the author concerning the flight of birds.

Aeronautical Engineering Materials. R. H. Thurston. *Cassier's Magazine*, September, 1894. Discusses the best materials to employ in order to secure strength combined with lightness.

Revue de l'Aéronautique, Paris, France, 120 Boulevard St. Germain; 10 francs a year to United States; quarterly; chiefly publishes carefully prepared memoirs on Aeronautical matters.

The Problem of Man Flight. James Means. 340 Washington Street, Boston, Mass.: W. B. Clarke & Co. Price, 10 cents. A proposal for promoting experiments with soaring machines.

The Flying Man. Vernon. *McClure's Magazine*, September, 1894. Describes the studies and experiments of Herr Lilienthal and the motor with which he is to carry on his experiments this year.

Notes on Aerial Navigation. V. E. Johnson, M.A. *Westminster Review* (British), September, 1894. Discusses the general question and indicates that Aerial Navigation will become an accomplished fact.

The Development of Aerial Navigation. H. S. Maxim. *North American Review*, September, 1894. Mr. Maxim gives a popular account of his experiments, including the one in July last, in which he actually flew.

New Lights on the Problem of Flying. Professor Joseph de Conte. *Popular Science Monthly*, April, 1894. Article modifying the previous assertions of the writer as to the impossibility of artificial flying machines.

The Prospects of Flying. H. S. Maxim. *National Review* (British), September, 1894. Mr. Maxim describes his experiments, and says that "what remains to be done is to learn to steer and to manœuvre the machine."

Aerial Navigation. J. G. W. Fijnje Van Salverda. Translated from the Dutch by George E. Waring, Jr. New York: D. Appleton & Co. 209 pp., price, $1.25. A summary in popular form of the present development and expectations of success in Aerial Navigation. The author is a distinguished Dutch engineer, now retired.

For Aeronautical Advertisements, see page xxiv.

AMERICAN ENGINEER AND RAILROAD JOURNAL.
(Formerly the RAILROAD AND ENGINEERING JOURNAL.)

PUBLISHERS' DEPARTMENT.

General Notes

The Bridgeport Machine Works, of which Mr. E. P. Bullard has been proprietor, has recently been incorporated under the name of the Bullard Machine Tool Company, E. P. Bullard being President. The business will be continued, as in the past, in the manufacture of machine tools.

The Atlantic Coast Line claims a run made from Jacksonville, Fla., to Washington, D. C., a distance of 780 miles, which, deducting stops, was done in 880 minutes, averaging 53¼ miles per hour; as the stops amounted to 169 minutes, the average time for the whole run was 44.8 miles per hour.

The Consolidated Car Heating Company, of Albany, N. Y., announce that Judge Swan, of the United States Circuit Court at Detroit, in a decision rendered August 21, denied the motion for a rehearing in the Cody patent case, thereby affirming a previous decision of the same court in favor of the Consolidated Car Heating Company of Albany, N. Y.

The Foster Engineering Company, of Newark, N. J., write us to call attention to the fact that in the paper descriptive of the auxiliary machinery of the *Columbia*, published in our issue for September, no mention was made of the use of their reducing valves, which, they say, are placed upon the pipes of each of the auxiliary engines, even the steam jackets of the main engines being so supplied. All of the cruisers of the new fleet are equipped with these valves.

The Youngstown Bridge Company have the contract for two-span four-track bridge for the Baltimore & Ohio Railroad at Bessemer, Pa.; a suspension bridge with eyebar cables, and two braced arch spans over Mill Creek Cañon, in Mahoning County, O., and a large head frame for shipment to Salt Lake City, Utah. They have also several large contracts at Springfield, Ill.; Bell County, Tex., and among other work, several spans in Oregon and some truss work for the American Sugar Refining Company at New Orleans.

The George F. Blake Manufacturing Company has recently closed a contract with the Commissioner of Public Works of New York for 4 high-grade, vertical, triple-expansion, crank and fly-wheel pumping engines, to be operated with 160 lbs. steam pressure. These engines are to be placed in a structure located between High Bridge and Washington Bridge, just west of the new speedway. The company has also recently taken a contract in the city of Boston for a 10,000,000-gall. pumping engine of the vertical triple-expansion type, to run with a piston speed of over 400 ft. a minute. The following naval vessels are also equipped with the Blake pump: the *Columbia, New York, Brooklyn, Minneapolis, Philadelphia, Marblehead, Montgomery, Detroit, Chicago, Boston, Atlanta, Maine, Indiana, Massachusetts, Iowa, Dolphin, Macchias, Castine, Puritan, Miantonomah*, the ram *Katahdin*, and the dynamite cruiser *Vesuvius*

Pintsch Gas in Houston, Tex.—Through negotiations which have recently been conducted by Mr. Clarence H. Howard, the Western representative of the Safety Car Heating & Lighting Company, arrangements have recently been made for establishing an extensive plant in Houston for manufacturing and supplying gas to all the different railroad companies centering there. This gas, as is well known, is manufactured by a different process from ordinary illuminating gas, and is then compressed so that it can be stored in the reservoirs on cars. The proposed plant includes compressing machinery, by which, to quote from a book criticised last month, the gas is "hammered into hard but elastic shape." The paper—the Houston *Post*—to which we are indebted for the above information says of Mr. Howard that he is "a genial, whole-souled fellow." That gentleman is reported as saying that all the railroad men in Houston are pleased at having a gas supply located there. When the compressing plant is completed the people of Houston will find, however, that it is easier to compress Pintsch gas than it will be to "hammer Howard into a hard but elastic shape." He is irrepressible.

The E. W. Bliss Company, Brooklyn, N. Y., report that their European business has been very large lately, and that they have shipped to Switzerland within the last two months a special watch-maker's drop hammer, and several punching presses fitted with sub-presses for watch work, also a No. 1½ toggle drawing press; a large shipment to Germany, to one of the largest clock-making concerns in the world, of tools and machinery for the manufacture of clocks and their cases. France has also received a large shipment of tools for the making of granite enameled ware and kitchen utensils. Several watch factories have also been supplied with tools. Austria has not been behind the others, as she has also received a No. 1½ and 3½ toggle drawing press, a No. 18, 19, 20 and 21 adjustable power press, and a No. 88½ and 89 power press, with a number of dies, and a No. 161 double-action press with dies and special feed for making primers. A large improved automatic perforating press is now nearly completed, and will be shipped to England for the manufacture of perforated metals up to 50 in. in width. This speaks well for American tools in competition with those of foreign make, and the company is greatly encouraged in this direction.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

Formerly the RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

The American Railroad Journal, founded in 1832, was consolidated with Van Nostrand's Engineering Magazine, 1887, forming the Railroad and Engineering Journal, the name of which was changed to the American Engineer and Railroad Journal, January, 1893.

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Berlin, Germany, W. H. Kühl, 73 Jäger St.

NEW YORK, NOVEMBER, 1894.

EDITORIAL NOTES.

THERE seems to be the faintest breath of air stirring preceding the dawn of better times. There is the usual shortage of cars that is always with us when there is any traffic to speak of. To be sure, this shortage, so far as we have heard, is a local matter, affecting only the coal roads of West Virginia; but the railroad reports, where it is possible to separate the freight from the passenger receipts, show that the former have picked up a trifle over the corresponding weeks in September of one year ago. Passenger receipts have naturally fallen off, owing to the loss of the World's Fair travel that was on the road in 1893, but the freight traffic is the barometer to indicate the business done, and this does seem to show a slight rise.

THERE seems to be an anti-step crusade sweeping over the country in the matter of car steps, but it is doubtful if there is more in it than in mere discussion. In cases like the elevated railroads, where rapid loading and unloading is an indispensable condition, and where no track work or inspection is ever done while the train is at a station, high platforms and no steps make the best arrangement; but where trains must be broken up, air and steam hose coupled, wheels inspected, and an occasional brake shoe put on, the high platform seems impossible. It was given a long trial on what is now the united railroads of the New Jersey Division of the Pennsylvania Railroad away back in the sixties, and was abandoned as troublesome and impracticable.

THE Canadians have the advantage over the United States in the matter of canals leading from tide water to the Great Lakes, and do not seem disposed to lose it. The latest move is to make a contract for the deepening of the Lachine Canal, by the terms of which that waterway is to be given a depth of 14 ft. As 14 ft. was, a few years ago, the maximum draft of lake vessels, this depth will, barring length of locks, be sufficient to allow the passage of most of the steamers plying between Buffalo and Duluth. Our readers will remember that in June, 1893, we illustrated a method of pontooning vessels through the St. Lawrence canals, that had to be used where the draft of the vessel was greater than 9 ft., which is now the nominal depth of the water. With the new improvement such troublesome expedients will be avoided, and Canada will have made another bid for the direct trans-Atlantic traffic from the interior.

As Canada decides to enlarge the Lachine Canal, the ship canal connecting the North Sea and the Baltic is approaching completion. This work is 61 miles long, is 200 ft. wide at the surface and 85 ft. at the bottom, with a depth of 28 ft., and is expected to be of great value to the German ports on the Baltic, while its strategic worth to the German Empire is acknowledged to be so great that Russia is taking immediate steps looking toward the reopening of the old White Sea traffic at Archangel, as noted by a correspondent in another column. If it will pay Germany to build an expensive ship canal cutting off Denmark from the mainland in order that the passage through the Skager Rack and Kattegat may be avoided, it certainly seems that the construction of a 14-ft. waterway from the Hudson to lakes Ontario and Erie would be a profitable investment, thus bringing the inland seas in direct communication with the sea at American ports, which would have an added advantage over their Canadian rivals in that the season of navigation is very considerably longer.

ON page 515 we reprint from the *Railway Engineer* the results obtained by Mr. Webb, of the London & Northwestern Railway, of England, with a compound engine of his designing. Our readers will remember that at the Master Mechanics' Convention, held at Saratoga last June, a letter was submitted showing the remarkable results that had been obtained by Mr. Buchanan with one of his engines hauling the Empire State Express as compared with the *Greater Britain*, a Webb compound locomotive in express service on the London & Northwestern Railway. In that comparison Mr. Buchanan's engine, No. 999, is shown to have burned 1.644 oz. of coal per ton mile, at a speed of 45.42 miles per hour, while the *Greater Britain* burned 2.012 oz., the average speed being 47.66 miles per hour. In the test which we now publish the coal consumption is put at .969 oz. per ton mile, including engine and tender, but with an average speed of 17.74 miles per hour. This shows a saving in fuel consumption of more than 41 per cent. per ton mile, including engine and tender, a saving which it is impossible to attribute wholly to the lower speed at which the train was run.

MEN WITH FINISHED MINDS.

A LETTER which was received in this office from a railroad manager recently reads somewhat as follows: "Yours of the —, calling attention to unpaid bill for subscription to the ——— *Journal*, is received. There are so many publications of this kind sent here, and as we have no time to look through nor read or derive any benefit from them or digest their contents, yours may be discontinued." Such letters, even to the most prosperous publisher and editor, always produce a slight sinking sensation in the region of the diaphragm. The intensity of this qualm of course bears some sort of inverse ratio to the length of the subscription list—or, perhaps, it would be more correct to say to the *condition* of the subscription list—that is, it is analogous to the effect of the motion of a ship on a seasick voyager—he or she feels the effect of the motion of the ship less when it is rising than when it is falling. In the latter case

such unhappy persons feel that the foundations of their stomachs have been removed. It is so with publishers and editors. When the subscription list is growing, and one or more new subscribers who are avid for knowledge are ready to take the places of those who have "no time" to acquire information, the newspaper man is more reconciled to lose an old patron than he is when the list of subscribers is diminishing. It is only expressing a truism or an every-day experience to say that subscribers are harder to get in hard times than they are in periods of prosperity, therefore we are disposed to discuss the question of the value and use of technical papers with those who write or feel as our correspondents do.

It is a common complaint that there are too many newspapers; but that is also said, and in a certain sense is true, of all other kinds of products of human industry or intelligence—there is too much iron, too much grain, hardware, machinery, books, etc. There is this curious fact though, that there is never too much of the *best* of anything; and it is true that there are not too many of the best papers. It will be observed that our correspondent don't complain that the paper which, with a slight show of indignation, he discontinued did not contain valuable information, but only that he "had not time to derive any benefit from it" nor to "digest its contents." Now, we have scriptural authority for the saying that "wise men lay up knowledge," and, conversely, it may be inferred that those who do not are not wise. In fact, the same once-venerated authority uses a very uncomplimentary term to designate those who "despise wisdom and instruction."

But Solomon was even more specific in his observation on this subject; and it seems as though, in a sort of prophetic vein, he must have had modern railroad officials in his mind when he wrote in his didactive way: "Receive instruction and not silver . . . and find out knowledge of witty inventions." Solomon, it will be observed, was a plain-spoken person, and talked as openly about things as the parties do who are conducting the investigations of the Lexow Commission into the delinquencies of the Police Department of New York City. While it is perfectly safe for an editor to commend Solomon's advice to "receive instruction," but if any "we" wanted to instil the second part of his first precept he would probably find it judicious to do so under the cover of a quotation.

Just what Solomon meant by the second part of this injunction, which has been quoted, it is perhaps not easy now to know. The language, though, has such an obvious application to existing conditions under which railroad operation is conducted, that we are are disposed to assume that the author of the Book of the Proverbs was writing prophetically when he gave the injunction to "find out knowledge of witty inventions."

It should be observed that this word "witty" is not here synonymous with *funny*, the sense in which it is ordinarily used. The derivation of the word "wit" is from a root or roots signifying *to see*, *to observe*, *to know*, or *to learn*, and in one sense is defined as "mind, intellect, understanding, sense, a mental faculty or power of the mind." In the expression, "are at their wits' end," it is used with this signification; and Shakespeare wrote:

> "A prince most prudent, of an excellent
> And unmatched *wit* and judgment."

Witty in the old sense meant knowing, wise, judicious. Substituting this latter meaning in Solomon's injunction, and the recommendation would be to "find out knowledge of *judicious* inventions." Just what Solomon meant by "inventions" probably we can't know, but doubtless the idea in his mind when he used the word which has been translated "*inventions*," was that of discovery of new truths. At any rate, the injunction to "find out knowledge of witty (or judicious) inventions" has greater significance, probably, when imposed upon railroad managers and others in charge of great engineering enterprises of to-day than it had on the contemporaries of Solomon who lived about 1,000 B.C.

Now, if any one were to try to describe the most marked and characteristic purpose and function of modern technical newspapers, it would appear that their distinctive field of effort is to explain, describe, and give information about "judicious inventions" and discoveries. Railroad operation is based upon these; and it would not be a very difficult task to show how successive inventions had developed the present magnificent system of modern transportation, from the rude beginnings of wooden rails and tram roads on which successive improvements have been laid like bricks on the foundation of a building, and the structure has risen and has assumed the present splendid proportions. It is "*judicious* inventions" which have done this, and they have been countless. If any one should undertake to write a history of the evolution of the form of rails of the present day and show how they have been developed from the old wooden timbers and strap form of iron rail, it would make a large book. Each change has been an invention—perhaps not patentable, but has been the result of the application of more or less ingenuity or intelligence. Of course there has been a vast and innumerable multitude of inventions which were not "judicious." There have been many more of that kind than of those which have survived. But the process of evolution has gone on all the time; trial and failure, with an occasional success which has survived, has been the rule. Often a distinct advance in mechanical evolution follows from proving that something is not so or not true. The results of experiment and invention are largely and necessarily negative in their character. A respectable-sized museum could be filled with models of the various forms of valve gear which were devised and used or experimented with before the link motion was invented. It proved to be the most "witty" of all the inventions. The process of evolution was a long and weary one, but the result was worth all the time and labor and thought and money which was expended on it.

It is needless to tell railroad managers now that the conditions under which the business of transportation must be carried on are exceptionally hard. Every available means must be employed to facilitate the work and reduce the cost. In looking backward on the history of railroad transportation, it will be seen that there has been a continual reduction in cost of doing work, due to improvements which have been inventions. The era of improvement and invention is not ended. It will go on as surely as the human mind retains its faculties and human hands do not "forget their cunning." Now, what sort of attitude ought a railroad manager to assume in relation to progress, improvement and invention? Undoubtedly his obligations and position impose judicial duties on him—that is, he must judge what inventions are "witty" or judicious, and which are not. How can he judge wisely without knowledge? and how can he know if he will not "receive instruction"? The aim of the technical newspaper of the present day is to gather and give the fullest information concerning improvements and inventions of various kinds which have been made. They give in different ways and with varying degrees of success and intelligence the latest obtainable information concerning the progress which is made. When our correspondent ignores the technical papers, as he has, he in effect says, "We have no time to get information about the science and art of transportation, or 'be benefited thereby,' nor 'to digest it.' We are so busy that we are compelled to remain in at least partial ignorance of the seething evolutionary processes which are constantly going on, and from which from time to time great improvements are developed." Solomon evidently had this class of people in his mind when he wrote, "If thou criest after knowledge and liftest up thy voice for

understanding, . . . then shalt thou understand righteousness and judgment and equity; yea, every good path. When wisdom entereth into thine heart, and *knowledge is pleasant unto thy soul.*"

There are some old-fashioned words whose original meaning it is sometimes worth while to recall. "*Righteousness*" is one of these, the meaning of which is "that which is right." Adopting an algebraic method and substituting this value in Solomon's formulæ, it would read, "If thou criest after knowledge thou shalt then understand that which is right." Now, it may appear merely fanciful to apply this proverb to the relations and duties of engineers and railroad managers, and yet how many cases might be cited of persons occupying positions of responsibility and authority who did not know "that which was right," because they had not been in the habit, as Solomon expressed it, of "crying out for knowledge," or, as perhaps we in these modern days would phrase it, had not been "reading the technical papers."

But the author of the Book of Proverbs goes farther and says that those who "cry after knowledge" shall also "understand judgment and equity; yea, every good path." Going to the dictionary again, we find that judgment is defined as "the operation of the mind, involving comparison and discrimination, by which a knowledge of the values and relations of things, whether of moral qualities, intellectual concepts, logical propositions, or material facts, is obtained," and one of the meanings of equity is "fairness in determination of conflicting claims." Adopting the mathematical method of commentating, and by a slight paraphrase it will be seen that what Solomon meant was that they who cry after knowledge (by reading technical papers) shall understand that which is right and shall be able to obtain a knowledge of the values and relations of material facts, logical propositions, moral qualities, and shall be fair in the determination of conflicting claims. But the Wise Man does not end even here; he promises that as a sequence to "crying after knowledge" that then "wisdom entereth into thine heart, *and knowledge is pleasant unto thy soul.*"

It is safe to say that there are a great many people to whom "knowledge is not pleasant to their souls," and it is to be feared that there are many railroad officers who belong to that class. Some one wrote an essay a number of years ago on the "Capacity of the Human Mind to Resist Knowledge." All minds have this capacity to a greater or lesser extent; if they had not probably most of us would go crazy.

We confess to this "capacity" about certain subjects, such as theosophy, female suffrage, loose car wheels, radial trucks, automatic couplers and lock nuts. There are, though, some things which it is our duty to know; and the general observation might be modified by saying that there are many people to whom what they ought to, and it is their duty to, know is "not pleasant to their souls." A long list of such subjects might be made. For example, it is doubtful whether it is pleasant to the souls of many railroad managers or conductors to know how to supply fresh air to the passengers who travel in their cars. Few superintendents of motive power seem to take delight in knowing how much coal their engines burn in doing a given amount of work; and we never knew but one master car-builder—and he is now dead—who seemed to take any pleasure in knowing which were the most comfortable seats which he furnished for the passengers who traveled in his cars. It is quite certain that it is not pleasant to Mr. Pullman's soul to know how hard the beds are in his sleeping cars.

Seriously, though, what the author of Proverbs evidently meant was that to maintain our sense of what is right, our ability to determine the values and relations of facts, logical propositions and moral qualities, and be fair in the determination of conflicting claims, we must "cry out for" or *seek* knowledge and cultivate a love for it. Experience teaches us that by doing this, as Solomon says, "knowledge is pleasant unto the soul," and that to a great many people who are not in the habit of keeping the avenues which lead to their minds open to the reception of new information, knowledge is not pleasant. When this occurs people stop learning, and very soon their minds are finished. We all know such persons, some of whom are railroad officers, but many who are not. We are all familiar with the phrase, "a finished town," and can form in our imaginations an image of what it represents. We also know the dreary desolation which comes over people whose minds are finished, and are prepared to agree with Solomon when he said, "The excellency of knowledge is that wisdom giveth life to them that have it."

NEW PUBLICATIONS.

THE STREET RAILWAY JOURNAL. Our esteemed contemporary sends us what it calls a "souvenir number," which is intended to make its decennial anniversary, which it celebrated at the thirteenth convention of the American Street Railway Association, which has been held in Atlanta, on October 17, 18 and 19. Language would fail us in the attempt to describe the magnificence of the souvenir number. All that the arts of photography, engraving, press-work and coated paper can do has apparently been done to add to the splendor of this number. It contains 122 pp. of reading matter and 43 pp. of advertising. It has first an article of 8 pp. on the American Street Railway Association, with portraits of its officers and many members; next an article of 16 pp. on Atlanta, the Convention City, her People and her Industries, also illustrated with more engravings than there is time to count; a description of the principal cities of the South and their street railway lines, 34 pp., also elaborately illustrated; an article on the *Street Railway Journal*—Ten Years of Progress, 10 pp.; a Short History of the Street Railway Industry, 20 pp., and then 33 pp. of "write ups" of various manufacturing companies and firms.

Altogether this achievement of our contemporary indicates prosperity, for which congratulations are in order; but why did they call it a "souvenir" number? The word has been so misused that it now always suggests theater programmes, the literary ventures of fire companies or chowder clubs. Excepting its title it is admirable.

ELECTRIC POWER, which is published in New York, has commenced the publication of a "Synopsis of Current Electrical Literature," which, no doubt, will interest many readers interested in electrical art and science. As a sort of vignette to this department, a portrait of the compiler, Mr. Max Osterberg, is printed, which may or may not be an additional attraction to this department of bibliography.

BOOKS RECEIVED.

ELECTRIC LIGHTING PLANTS, THEIR COST AND OPERATION. By W. J. Buckley. Chicago: William Johnston Printing Company. 275 pp., 4¾ × 7 in.

TRADE CATALOGUES.

MESSRS. BAKER & CO., of Newark, N. J., send us a little pamphlet, 34 pp., 4¾ × 8 in., with the title "Data Concerning Platinum," etc., in which various utensils made of this metal are described, and much useful information is given with reference to their use and care, and data regarding the weight, etc., of this little-known metal.

ILLUSTRATED CATALOGUE AND PRICE LIST OF FIRE HOSE, Manufactured by the Boston Belting Company, Boston and New York. 29 pp., 3¾ × 6¼ in.

The first part of this publication gives a description of various kinds of fire hose made by the company. The remaining portion is devoted to illustrations and descriptions of a test pump, hose racks, couplings, hose pipes, and miscellaneous information relating to nozzles, pressure and height of streams which will be thrown under different conditions.

CATALOGUE OF 1894. The Tanite Company, Stroudsburg, Pa. 47 pp., $3\frac{1}{4} \times 5\frac{1}{4}$ in.

This catalogue of the Tanite Company starts out with a "plea for a better appreciation of the grinding industry," following it up with a discussion of the cost and worth of machinery intended for such purposes. There are some valuable practical hints regarding emery wheels, which are classified into coarse-hard, medium-hard, medium-soft, etc., with information as to the uses for which they are adapted. The pamphlet is illustrated, and shows twenty different kinds of machines. After the illustrations there are some remarks about emery, emery oil stone, emery knife sharpeners, liquid polish, polishing paste, knife powders, aluminous paint, etc. On the last page there appears what to us, at least, is a novelty, and that is a bibliography of the publications that have been issued by the company, including six treatises, papers and brochures that are interesting to persons using emery grinding machinery, and to those whose work could be facilitated by its use.

THE VULCAN IRON WORKS COMPANY'S CATALOGUE OF STEAM SHOVELS AND STEAM DREDGES. Toledo, O. The pages are not numbered, and there is not time to count them; but they are $6\frac{1}{4} \times 9\frac{1}{4}$ in., and there are a good many of them. The publication begins with a general statement of the advantages of these dredges and steam shovels, which is followed by a perspective view, made from a photograph, of one of them, and *fac-simile* copies of testimonials of its merits. A general description of the construction of the machines is then given, and more views of them, showing the different kinds which the company builds at work on different classes of work and intended for different purposes. The reader will get a very good idea of the character of the various machines made by this company from their catalogue, and the work which they are intended to do. Some loose leaflets are also inserted in the book which describe the "Giant Railroad Excavator and Wrecker Combined," and a full description of it, and also of their "Railroad Excavator," with more testimonials.

TOWER, TANK AND TUB CATALOGUE of the W. E. Caldwell Company, Incorporated, Louisville, Ky.

The first four pages of this catalogue contain tables of sizes, capacities, etc., of tanks made by the company. These are followed by illustrations showing the construction of Tecklonius' patent lugs, which are used on the hoops of wooden tanks. A number of illustrations are then given of various styles of iron and wooden towers for supporting tanks. An excellent chapter is added on the importance of secure foundations for tanks and of sufficient strength in their supports. The W. E. Caldwell Company recommend cypress timber for wooden tanks for the following reasons: "It will last for ages without decay; it does not shrink and swell like other woods; it does not warp and twist when exposed to the weather; it has not the knots and defects found in white pine, cedar and other woods, and, when seasoned, it is lighter than all other woods, assuring cheaper transportation."

The company also make iron and steel tanks, and illustrate and describe a railroad water tank and its details, of which they make several sizes.

CATALOGUE AND STEAM USERS' MANUAL. Published by the Star Brass Manufacturing Company, Boston, Mass. 190 pp., $8\frac{1}{4} \times 6\frac{1}{4}$ in.

On the title-page of this little book the publishers say that they are manufacturers of pressure and vacuum gauges for all purposes, stationary, portable and marine pop safety valves, steam engine and boiler appliances in general. It would make too long a list to enumerate all the different articles which are illustrated—most of them by excellent engravings—and described in this convenient little volume. It must suffice now to say that it includes steam, vacuum, air brake, hydrostatic, test and ammonia pressure gauges, fittings for the same, engine-room clocks, engine registers and revolution counters, recording gauges, gauge frames, test pumps and other boiler-testing apparatus, steam engines, indicators and their fittings, pop safety valves, thermometers, salinometers, hydrometers, pyrometers, calorimeters, water gauges and water columns, gauge cocks and their fixtures, steam whistles, lubricators of many kinds, and pipe fittings, etc. These are all—excepting the pipe fittings—represented by excellent engravings. The latter are poor "process" reductions from larger engravings. The book also contains 30 pages of "Useful Information for Engineers and Steam Users." A good index completes this excellent example of a trade catalogue.

ILLUSTRATED CATALOGUE OF BOLT AND NUT MACHINERY Manufactured by the Acme Machinery Company, Cleveland, O. 108 pp., 6×9 in.

The class of machinery manufactured by this company includes bolt cutters, nut tappers, and bolt heading, upsetting and forging machines. These are illustrated by good wood-engravings, with descriptions and data on the opposite pages. The first illustration is a view of the works. This is followed by a *fac-simile* engraving of a large square threaded screw, cut on one of the machines made by the company. After this various illustrations and descriptions of details of the bolt cutters, showing their construction and operation. Views are then given of 12 different sizes of single bolt cutters, which will cut bolts up to 6 in. in diameter. Four sizes of "double bolt cutters," with two spindles, are then shown, which will cut up to 2 in. in diameter. Six different patterns of nut tappers, with vertical spindles, several kinds of "pointing machines," for shaping and finishing the points of bolts and studs, three sizes of smaller single bolt cutters, a double stay-bolt cutter, a machine for tapping carriage axle nuts, a turret nut-facing machine, a 2-in. taper threading machine, and five sizes of bolt-heading, upsetting and forging machines are described and illustrated. The last engraving illustrates a variety of different kinds of work which can be done on the machines last referred to. The book ends with a long list of names of firms and companies who are using the machines made by the Acme Company. Persons who need such machines are advised to write and get a copy of this catalogue.

RE-ROLLING STEEL RAILS.

Editor of THE AMERICAN ENGINEER AND RAILROAD JOURNAL:

YOUR letter of September 19 is at hand, and in response thereto I beg to say that the process for which I have secured a patent for renewing old rails is a very simple one, and does not require any special machinery beyond a furnace adapted to the heating of rails 30 ft. in length. This is longer than the furnaces in use in rail mills, and requires some special features of construction, which are usual, however, to long furnaces which are used for heating metal for other purposes.

The rolling machinery that is used is that usual to rail mills; an ordinary two-high or three-high mill can be used under different conditions to accomplish the result.

I do not know how much information you have concerning the process, and will explain at length the conditions which induced the conception of the invention, and its practical results as thus far developed. You are doubtless aware that it is a custom on many Western roads to subject rails to the sawing process—*i.e.*, where the flowage of metal has been extreme at the ends and not excessive through the body of the rail, the ends are sawed off, reducing the length of the rail about 10 per cent., and the rails thus reclaimed are laid in the track. The product of this process is about as follows: 70 per cent. relayable main track rails; 20 per cent. side track rails; 10 per cent. scrap in crop ends. The result of this system is not satisfactory, for the reason that the 70 per cent. of relayable rails are more or less worn on the tread, and it has been found impossible to secure even butt joints on account of the unequal wear of the rails during their previous life, and the unequal plane where the rails are joined makes the subsequent deterioration very rapid.

The sawing process costs something, and as 10 per cent. of the rails are reduced to scrap, and the shortening of the rails calls for 10 per cent. additional joint material, it is very evident that the process in view of the result is expensive. With the experience gained from watching this operation, the suggestion came that the rails were not worn out, but were rendered unserviceable on account of the flowage of the metal in the tread due to rolling impact. In short, that the loss of metal by attrition was very trifling, and all that was necessary to restore the rail to its original usefulness was to replace the displaced metal.

To verify my observation, I at different times had rails of different weight and section, after they had been removed from the track to be subjected to the sawing process, weighed, and found that rails of 60 lbs. to the yard, after from 10 to 14 years' service, had lost from .117 to .135 lb. per yard, and rails on 67 lb. section, after seven years' service, had lost .087 lb. per yard.

The process patent that has been granted me consists of two steps: 1. Heating below the decarbonizing point; 2. Replacing the displaced metal. Practical experiments that have been made demonstrate conclusively the fact that rails, such as are now subjected to the sawing process, can be renewed with a loss of transverse section not exceeding 2 lbs. per yard, one-half of which is saved in the elongation of the rail, so that the net loss is about as follows: Oxidation, .50 lb. per yard; crop ends, .50 lb. per yard. Experiments have also developed that in rails that were elongated as much as 12 per

cent. the bolt holes are rolled into an oval form, but were less than ¼ in. out of center, and were changed to the circular form by a simple swagging process, which does not cause any material upsetting of the material in the web surrounding the holes; as the elongation, however, in ordinary practise would not exceed from 1 to 3 per cent., this feature of the process is readily met.

In the process above outlined there is necessarily some reduction of the width of the flange in order to secure equable draft through the holes to reshape the metal in the head. This reduction of the flange for obvious reasons would militate against future successive renewals of the rail, which is a valuable economic desideratum for railway interests. To meet this point, I have invented a machine, in the operation of which the web and flange of the rail are maintained intact, the metal of the head only being worked upon. In this machine there is no distortion of the bolt holes. The metal in the head of the rail is put in shape by pressure imposed in a vertical line upon the tread—that is to say, the metal is worked into position in the line of the subsequent work it is called upon to perform.

I have no drawings at hand to illustrate its workings, or I should be very glad to send them to you. If the invention will accomplish the results sought for, it is evident that the steel rails of 75 lbs. or upward in section, which is now cast away at the end of one life, can be renewed at trifling cost and be made to serve from five to 15 lives.

I forgot to mention in the proper place that chemical and physical tests of the rails renewed by this process were made, and it was found that the chemical constituents did not undergo any change, "the hardeners" remaining practically the same as before, and the physical properties, as demonstrated by etchings taken, show that the physical structure of the rail was improved. E. W. McKenna.

THE KLEIN AND LINDNER LOCOMOTIVE.

To the Editor of the American Engineer and Railroad Journal:

In the March number of the American Engineer and Railroad Journal I find a mention of the American patent that has recently been issued to Herr R. Lindner and myself for a locomotive with a flexible driving-wheel base, the compensation for which is accomplished at the end axle. At the conclusion of the description is the criticism that if the radial axle, when it is running ahead, and one of its wheels comes in contact with the outer rail, instead of assuming an inclined position that would be radial to the curve, would be inclined in the reverse direction, and that it would be better that the hollow axle should be mounted in a Bissel truck, with a radial bar made fast to a pivot just ahead of the center axle.

I beg that you will allow me to correct this error in your esteemed journal. The Klein-Lindner patent coupled radial axle is a free radial axle, since it has been used for many years under Nowotny's patent as the leading axle on locomotives in hundreds of applications on the Royal State Railway of Saxony, showing great advantages both in the saving of the wheels and the easy curving of the machine; on cars the freely adjustable axle has furthermore been used for about 20 years on the Royal State railways of Saxony, an application which has been found to be so advantageous that it is finding a still wider field on the German railways. The radial adjustment of the free axle is many times more certain in its application when the axle is running ahead, though it is not readily understood. By running the axle at the back the tendency is present to pass beyond the radial position. Now the forward axle, as well as the back axle, is put in the proper position, since both axles are so connected, the one with the other, that the equal adjustment of both must follow, and there results a uniformity in the position of both axles, and each one moves into a line with the radius to the curve at the point where it is situated at the time.

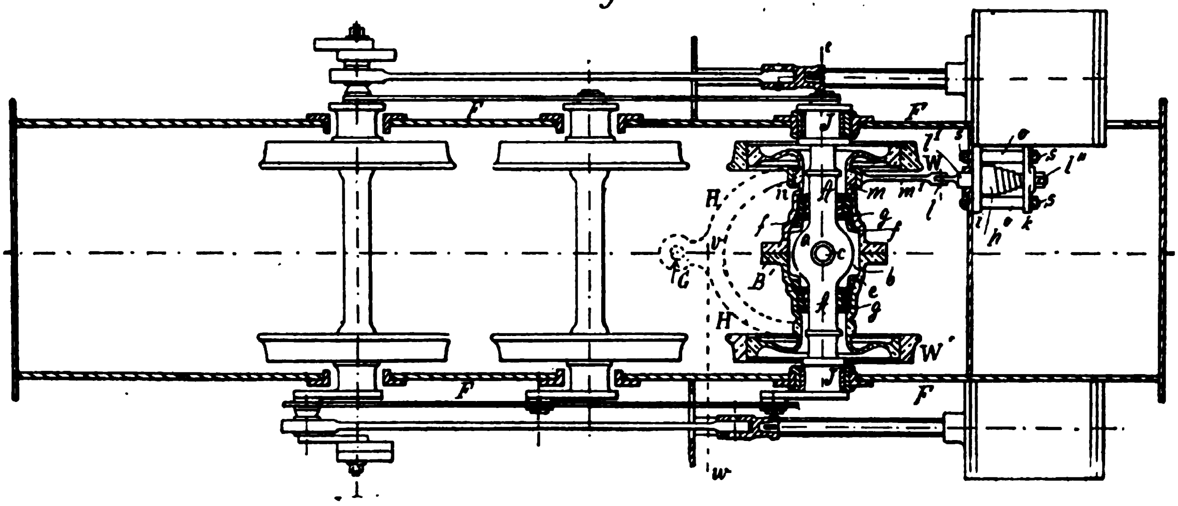
Furthermore, it is a demonstrable proposition that the adjustable axle, as soon as the back wheels strike the curve, instead of keeping its wheels bearing against the outer rails, it (the forward axle) is brought over to the other side, and is thus in a radial position whether or no, so that, instead of the adjustable axle having a tendency to continue in the line of a tangent to the curve, it travels in a line at right angles to the radius, being brought there in spite of itself through the influence of the radial back axle with the least possible angular inclination (an angle which the plane of the wheel makes with the tangent at its point with the rail in its running position) to the outer rail of the curve.

In this position the free axle needs no thrusting in the line of its length, as it is necessary to do, to a great extent, with the Bissel axle in order to keep it in a radial position. By running this radial axle in a Bissel truck as the back axle a very unfavorable condition of affairs would result, since, in consequence of the short wheel base of the two rigidly fastened axles, the true radial position is always located nearer to the center axle, and they run at a somewhat sharp angle to the outer rail. Hence the oblique position of the center line of the machine to the center line of the track causes a corresponding inward motion of the pivot of the Bissel truck, preventing the axle from assuming a true radial position that is radial to the outer line of rails.

The Klein and Lindner patent coupled radial axle possesses all of the properties of the free radial axle, and is, by the application of a hollow sleeve carrying the wheels, and which, having a bearing only at the center, is connected by a ball bearing to the central axle, so that it can freely adjust itself on the rails as well as on the inner core axle, which runs through it, and which is made rigid in the ordinary way, being fastened in the frames and coupled to the other driving axles with the usual attachments. The object of the hollow axle with the ball bearing at its center is that any variation of the axle from its horizontal position still leaves the weight upon the two wheels as conveyed to them by the hollow axle the same.

The springs attached to the hollow axle are for the purpose of easing the shocks and side strains upon the locomotive when it is running over curves and uneven places; and it only comes into action to assist the radial action on very sharp curves, and then acts finally to check the backward motion of the axle and bring it into the central position as soon as the

Fig. 3



KLEIN & LINDNER'S LOCOMOTIVE.

pressure causing the displacing action ceases. These springs are made with such a tension that they only come into action by the exact amount to be attributed to the curve; the arrangement is also so adjusted that one spring is always working and the other is always standing in the corresponding central position.

I send a pamphlet giving such further information on this subject as may be desired, which also fully explains the whole of the details. The hollow adjustable three-axle locomotives for .75 meter (29½ in.) gauge have proved themselves pre-eminently successful. The first, which has been in service for 3 years, is shown by the latest locomotive report to have cost nothing for repairs to the ball bearing during all the time that it has been in service. The tires on the hollow axle were, in consequence of the radial position, hardly worn at all in the flanges, while the corresponding end axle held in rigid bearings showed sharp flanges on its wheels at the end of a run of about 30,000 kilometers (18,600 miles), while the engine having the flexible axle has traveled half as many kilometers more.

With the four-axled locomotives which are now in course of construction, wherein the two end axles will be of this flexible type, it is expected to obtain equally favorable results.

CHEMNITZ, GERMANY. RICHARD KLEIN.

[Owing to an oversight, the publication of this letter has been delayed for several issues, and we therefore republish the plan of the Klein-Lindner locomotive that appeared in our issue for March, and which is here referred to.—ED.]

NOTES AND NEWS.

New English Torpedo-boat Trial.—No. 95, the second of three first-class torpedo-boats which are being built by Mr. J. S. White, of East Cowes, was officially tried in the Solent recently. During the three hours' steaming the boat made six runs with and against the tide on the measured mile, and realized a speed of 23.21 knots, which was slightly beyond the requirements of the contract.

The Oldest Oil Well.—The Oil City *Derrick* says that there is an oil well at Rockwood, about 4 miles east of Oil City, which was drilled by Charles Lay in 1840 for salt. A vein of oil was struck, and it impregnated the water to such an extent that it was valueless for salt-making. No use was then known for the oil, and it was abandoned. During the oil excitement the well was drilled deeper, and it pumped oil for several years, but later it was abandoned. Recently it has been sputtering gas and oil, and may be cleaned out and make a fair-sized pumper.

The Great Railway Bridge Across the Delaware.—The plans submitted for the gigantic railway bridge across the Delaware River to connect Philadelphia with Camden, N. J., have been approved by the War Department, the only condition required being the location of the draw. The bridge is to be built by the Pennsylvania Railroad Company, whose chief engineer, William Brown, approved the plans. It will be high enough to permit the passage of ferryboats at any point. The draw will accommodate ships with the tallest masts. This bridge will give through rail connection to the seashore and New Jersey towns. Work, it is said, will commence within a year.

Boilers in French Torpedo-boats.—Many types of boilers are in use in the French Navy—as locomotive, Trépardoux, Oriolle, Petit-Godard, Du Temple, and others—all, save the first named, upon the water-tube system. The Du Temple boilers, as modified by M. Normand, with tubes of two diameters, present great facilities for repair by replacing tubes. They have been unfavorably reported upon by the engineers of the seagoing boat *Dragon*, and Chief Engineer Fulcrand condemned them as satisfactory only for short trials of two hours' duration; but Captain Vidal warmly favored them for the boats of the mobile defense. They have given the best results under his own observation.

Brooklyn Bridge Car Illumination.—At a recent meeting of the Brooklyn Bridge trustees it was decided to light the cars which run on the bridge with some kind of electric light. The bids for this service were as follows: The General Electric Company engaged to furnish the apparatus to light 60 cars, each with 10 lamps of 16 candle power, for $14,200, the cost of running the same to be $4,905.60 a year. The bid of the Electrical & Mechanical Trading Company was $17,634 for the apparatus and $3,409 annual cost of running. The Pintsch Gas Company's bid was $14,707 for the apparatus and $5,764 running expense. The question as to which of the electric companies should have the contract was referred to Superintendent Martin. It is understood that duplicate wires are to be put up in all the cars. Three months will be required to make the change.—*New York Sun.*

Mysterious Electrical Experiments by the U. S. Lighthouse Board.—It is reported this Board is engaged in some experimental electrical investigations off Sandy Hook. The New York *Sun* said recently that several weeks ago the Board gave public notice that it was going to begin, and warned masters of vessels not to anchor or pass within 1,000 ft. of the lightship. With that preface it began to lay a network of submarine cables, the location of which was marked by small floating wooden buoys resembling logs of wood. A submarine cable was also laid from the Scotland Lightship to a landing-place on the northeastern point of Sandy Hook, opposite the marine telegraph station of the Western Union Telegraph Company. Having installed the plant, the electrical experts began work, and have been hard at it ever since. The Board refuses to give information about the experiments, but says they will be made public when completed.

Official Trial of the United States Battleship "Maine."—The first official trial of this ship was made in Long Island Sound on October 17. The daily papers reported the following data concerning the trial:

"During the 4 hours under forced draft the general average of steam pressure was 141 lbs. at the boilers, the propellers making 127 revolutions a minute. Although the trial was for H.P. the *Maine* came up to designed expectations in speed. At about 3.30 o'clock the official trial course which was recently buoyed for the speed trial of the torpedo-boat *Ericsson* was reached, and then began a run of 25 miles of a surveyed course, the buoys being 3 miles apart. On the basis of the total elapsed time for the 25 miles, the average speed was 15.95, or practically 16 knots per hour, and, with a mean average allowance for tide, which was the last of the ebb at the final buoy, of about 1¼ knots, the result is 17.25 knots."

A Perilous Ride.—Probably one of the most thrilling rides ever heard of occurred on the Lebanon Valley Branch of the Reading Road recently. A young man crawled into the ash-pit of a Wooten engine at Harrisburg. The pit is divided in two sections, and both are directly beneath the fire grates. He entered through under the door of the fire-box and took a seat in the second compartment unobserved by the engineer or fireman. Shortly after taking this position the engine was attached to the fast line and started for this city. When the train stopped at Robesonia, 12 miles west of Reading, the fireman was startled by seeing a tall young man, all covered with ashes, stick his head out of the opening below the fire-box door and ask, "How far is it to Reading?" "How did you get in there and where?" asked the fireman. "At Harrisburg." "And you were not burned?" "Well, it kept me hustling to dodge the hot coals as they dropped down on me. It was a great ride, pardner," he said, and hurriedly left as the train pulled away from the station. The engineer says the only thing that saved the man from being burned up was that the fire had been puddled with large coal before leaving Harrisburg.—*Philadelphia Ledger.*

A New British Battleship.—The keel plate of the *Prince George*, first class barbette battleship, was laid down at Portsmouth recently. The *Prince George* is a sister ship of the *Majestic*, and consequently is of somewhat larger dimensions than those of the ships of the *Royal Sovereign* class. Her length will be 390 ft., her breadth 75 ft., and mean load draft 27½ ft., with a displacement of 14,900 tons, while the total weight of the protection material of the hull (including the protection of the auxiliary armament and protective deck) is to be greater than the corresponding weight in the *Royal Sovereign*. The thickness of the side armor has been reduced from 18 in. of compound plating to 9 in. of Harveyized steel armor. The battleship will carry four 12-in. breechloaders, contained in two barbettes, and the mountings will be so arranged that the guns can be loaded in any position by manual power. But the main armament will be carried 4 ft. higher than the guns of the *Royal Sovereign*, with increased freeboard in proportion. The secondary armament will consist of twelve 6 in. and 28 smaller quick-firing guns. Bilge-keels 200 ft. in length and 3 ft. in depth will be fitted. The contract for the engines has been placed with Messrs. Humphreys, Tennant & Co. They are to develop 12,000 H.P. under forced draft, and 10,000 H.P. with natural draft, and are estimated to give the ship a speed of 17½ and 16½ knots.

Meteoric Photography.—In a special dispatch to the New York *Evening Post* it is said that partly as a result of the accidental photographing of a large meteor nearly 2 years ago by Mr. Lewis, of the Yale Observatory, the money was raised last summer for securing a "battery" of four cameras, so as

to cover a larger field of the heavens, and, if possible, obtain more comprehensive and valuable results. These cameras were worked for 4 hours during the annual meteoric shower of last August, but, as is stated, merely by bad luck, only two meteors were obtained as compared with four obtained in 3 hours by a single camera during a previous meteoric shower. The battery will next be turned on the heavens during the showers coming about the middle and near the end of next month. Small as the number is of meteors thus far photographed, the results are considered to be of considerable value, inasmuch as one of the meteors photographed at the Yale Observatory was also obtained by Mr. Lewis at Ansonia, some 10 miles away, by a single camera. This, Professor Newton states, is the first recorded case of photographic double observation of a meteor, and from it nearly its exact distance can be computed. Each photograph shows two bursts of light in the meteor's path. It is a curious fact that an instructor in astronomy at Yale some 40 years ago predicted this new method of taking meteors by a camera battery should photography ever reach the proper stage of development.

Corrosion of French Torpedo boats.—In the inspection of torpedo-boats in the French Navy, it is said, in the London *Times*, that "grave defects have become apparent in the plates of several of them, but the Directorate of Naval Construction believes that it has now discovered the cause. It attributes the perforation and corrosion which have been discovered to the oxidizing action of the decomposed minium, with which the hulls have been painted, upon the zinc-covered plates. Upon this matter Chief Engineer Fulcrand afterward gave some very curious evidence. If, he said, one of the plates were put in a vessel of seawater having upon it a pot of minium, a ring of white salt would form round the pot even within a quarter of an hour. Of the chemical action thus set up there can therefore be no doubt. The phenomenon is not new, for it formerly led to the adoption of black paint, and now an iron-gray color has been adopted. Captain Vidal, however, speaking guardedly, said he should be surprised if the minium were the only cause of the defects discovered. He mentioned some curious circumstances within his experience. In March, 1893, torpedo-boats Nos. 143 and 144 being ordered to Corsica, it occurred to him to pass them through dock, and but for this they would have been sent to sea with grave defects in their hulls. In effect, so bad was the state of No. 143 that Captain Vidal, placing his finger in one of the *piqûres*, broke through the thin wall that still remained in the interior. The boat had been docked four months before, but he could not believe that defects so grave could have been produced within that period."

Sheathing and Speed.—A report has recently been made to the Navy Department showing that in a voyage of 675 miles of the United States ship *Bennington*, she made a speed of 7.85 knots per hour and burned a tenth of a ton of coal per mile. In another voyage she steamed only about 6.20 knots and burned nearly twice as much coal. The difference is attributed to the condition of her bottom, which was cleaned during one voyage and foul on the other. Other instances are quoted of similar effects in other ships. Commenting on this, a writer in the New York *Sun* says:

"The lesson in these various instances is plainly the advantage which the old wooden-sheathed vessels possess over the new steel fleet in their capacity to keep the sea very much longer without needing to be cleaned. The adoption of the policy of not sheathing the new steel vessels was deliberate. It was desired to get the maximum speed, and it is of course evident that the weight of sheathing is so much extra to be carried along by the same engine power. It is also so much clear addition to the original cost. At that time, also, there were some doubts as to the wisdom of sheathing steel vessels, on account of the galvanic action which it was feared would be set up between the two metals. Finally the English, on whose practice our first steel cruisers were largely based, were in the habit of making most of their steel cruisers unsheathed.

"But such facts as the foregoing have led some of our naval experts to question strongly the wisdom of our policy in this respect. Granted that the maximum speed attained by unsheathed cruisers must be greater than if they were sheathed, yet, on the other hand, we see how enormously speed is reduced by foul bottoms, and also how much more liable steel vessels are to fouling than are wooden. Then as to the question of cost, it is urged that this is in favor of sheathing, in consequence of the greatly increased consumption of coal, as in the case of the *Bennington*, already cited. To this must be added the great cost of more frequent docking. The absence from duty for such docking is still another point. At all events, it might be well to have some sheathed gunboat or composite craft for service in tropical waters. The English have many such."

Explosion of 27 Boilers.—Twenty-seven of a nest of 36 boilers at the Henry Clay Colliery, near Shamokin, Pa., exploded about 7.30 o'clock on the morning of October 11, completely destroying the boiler house, killing five men, seriously injuring two, and slightly injuring four. The explosion occurred just after the colliery had started work for the day. It was a very cold morning, and the men who were killed and injured were standing around the boilers getting warm. The men in the inside working had to walk to the surface, as the cars could not be run. The big boiler house and several adjoining buildings, such as the blacksmith shop and storehouse, were completely wrecked.

Without warning the last boiler on the west side of the nest went up, and it was followed by the others in rapid succession. The workmen were knocked in every direction, and what had been a strong corrugated iron building disappeared as if by magic. All that remained was a mass of bricks and timbers, pieces of twisted pipe and battered boiler iron.

The nine remaining boilers were so injured that they can never be used. Pieces of heavy steel were carried hundreds of yards, while a half of a boiler was found over a quarter of a mile away up the mountain.

One cause to which the explosion is assigned is that the boilers had become greatly weakened by the mine water that was used during the long drought in the summer. Lime was used to neutralize the acids in the mine water, but the boilers are said to be quickly eaten away by this water.

The colliery is operated by the Philadelphia & Reading Coal & Iron Company, and is the best-equipped plant of that company in this region. The pecuniary loss is $100,000. Sixteen hundred men and boys are thrown out of employment. Coal from the Sterling and Big Mountain mines was prepared for market at the shaft-breaker, which is constructed of iron. The shaft pay roll amounted to $40,000 per month. It will take six weeks before the plant will be able to resume.

Work of the Patent Office.—A striking feature in the preliminary report of the Commissioner of Patents is the falling off of applications during the year.

While in the fiscal year 1894 only 39,206 applications were made, there were 43,589 in 1893, 43,544 in 1892, 43,616 in 1891, and 43,810 in 1890. Thus it would appear that years of business depression are not conducive to inventive activity. The falling off in applications has resulted in a decreased income from fees, the net receipts having been $1,183,523.18 and the net expenditures $1,053,962.38. A surplus of $129,560.80 remained, therefore, to be carried over to the balance in the United States Treasury on account of the patent fund, which, on June 30 last, amounted to $4,409,366.74.

The Patent Office has done remarkably well in getting its work more up to date than in previous years. At the end of the fiscal year there were only 7,076 applications awaiting action on the part of the office, against 8,283 in 1893, and 9,447 the year before. Commissioner Seymour calls attention, nevertheless, to the pressing need for more clerical assistance, and his statement that only eight out of the 34 divisions of the office had their work within one month of date and 16 divisions were 2 months behind, would appear to be abundant evidence of such need for increase in the force.

Probably the most important work done during the last year has been the classification of the 522,185 patents issued during the history of the Patent Office up to June 30, 1894, which will be published in this year's report in full. The work is entirely new and represents a vast amount of labor. The classification consists of 212 classes, and about 5,000 subclasses, and the figures are a most interesting index of the inventive activity of this country during the existence of the patent system. Some of the largest lists of letters patent issued are the following: Trade marks, 24,938; designs, 23,407; stoves and furnaces, 18,500; railway cars, 14,600; carriages and wagons, 18,000; lamps and gasfittings, 10,000; boots and shoes, 10,000; packing and storing vessels, 10,500; harvesters, 10,000; clasps, buckles and buttons, 9,000; locks and latches, 9,000; harness, 9,500; pumps, 9,300; seeders and planters, 9,000; steam engines, 8,500; railways, 8,000; plows, 8,600; mills, 8,000; measuring instruments, 8,500; butchers' hardware, 8,200; apparel, 7,500; beds, 5,000; chairs, 4,200; fences, 6,600; firearms, 6,640; metallurgy, 7,600; water distribution, 6,000; sewing-machines, 6,500; steam boilers, 5,800; printing, 6,380.

Electrical Schools.—During the World's Fair in Chicago a series of lectures by practical electricians in charge of electrical exhibits was commenced. The applications for admission to these lectures were so numerous that they had to be abandoned owing to the impossibility of accommodating those who

wished to attend, and the discrimination which had to be made created so much dissatisfaction that they were abandoned. The interest in them was not allowed to die out, however. Mr. Edison and Professor Barrett, chief of the Electrical Department, and Professor Carhart, President of the Board of Judges at the World's Fair, determined to reorganize the whole plan on a permanent basis and along the philanthropic lines for the education of the people in the commercial side of electricity.

The National School of Electricity was organized during or after the World's Fair on lines that had never been attempted before in any educational enterprise. The lessons that make up the course are so written as to be within the limits of the mental capacity of mechanics, engineers, and young persons who have not had the benefits of a scientific or advanced education. The lessons are written without the use of the higher mathematics, and are taught almost entirely by the "object-lesson method."

The educational faculty, as it stands now, after several months of hard labor to cover all the branches of practical electricity in its make-up, is, Thomas A. Edison, Dean; Mr. Nikola Tesla; Professor H. S. Carhart, of Ann Arbor University; Professor Harris J. Ryan, of Cornell; Professor William A. Anthony; Professor B. F. Thomas, of the University of Ohio; Professor D. C. Jackson, of the University of Wisconsin; F. A. C. Perrine, of Leland Stanford University; Professor Brown Ayres, of the University of Louisiana; Professor George D. Shepardson, of the University of Minnesota; Professor Elisha Gray; Professor M. O'Dea, of Notre Dame University; Dr. W. J. Herdman, of Ann Arbor University, and Professor J. B. Barrett, chief electrician of the city of Chicago. The teaching is done by means of classes organized in various parts of the country and at several places in the large cities. The work is arranged by members of the faculty, by thoroughly experienced instructors, and makes use of large quantities of electrical apparatus.

As the scheme to a certain extent was an experiment it was decided to start it in Chicago, where it had its birth, with a view to discovering how the plan would work before attempting to perfect the organization in other centers of the country. The first class was organized last June in Chicago, and since that time more than 40 classes have been organized in Chicago and other places in Illinois, in Minnesota, Michigan, Wisconsin, Missouri, Indiana and Ohio, with a total membership of about 1,500 students. In Chicago the school was put into the Armour Institute as the elementary course in electricity. The main office of the school in New York City is in the Decker Building, Union Square.

The New American Atlantic Steamers.—The old adage that, in order to get the news, it is necessary to go away from home, is illustrated by a letter in the *English Mechanic* on the above subject, written by Mr. I. McMurray, of Baltimore, Md., which contains such a good description of these new steamers that we reprint it. Mr. McMurray says:

"Those of your readers who take an interest in the modern Atlantic steamers for mail and passenger service will perhaps like to read the following particulars of the vessels that are building as additions to the American line of the International Navigation Company. It may be remembered that the company were permitted by Congress to place under the American flag two of their fastest British-built ships, provided that they constructed others of equal or higher class in the United States. The company accordingly placed the Inman liners *City of New York* and *City of Paris*, on the Southampton route, dropping the 'City of' from their names. The new vessels now approaching completion at Cramp's Yard, on the Delaware, will also be named after cities, the *St. Louis* and the *St. Paul*, but will differ in appearance from the quondam Inman liners by having two funnels instead of three—still preserving, of course, the white band near the top as the mark of the line—straight stems, and two pole-masts instead of three. They are the first Transatlantic passenger steamers to be built in the United States for a period of over 20 years, and they will be compared with the most recent productions of British ship-builders. They are the largest vessels ever constructed in America, their principal dimensions being: length over all, 554 ft.; length on load-water-line, 536 ft.; extreme breadth, 63 ft.; molded depth, 42 ft.; tonnage, gross register, 11,000 tons. They are, therefore, not so large as the *Paris*, and not nearly so large as the latest Cunarders. The hull of each vessel has a double bottom constructed on the cellular principle, subdivided by athwartship bulkheads and a longitudinal division. They are so subdivided by transverse bulkheads, that even in the event of a collision and injury to a bulkhead, whereby two compartments might fill with water, the ship may still float in perfect safety. They have a straight stem and elliptical stern, topgallant forecastle and poop, with close bulwarks fore and aft, two pole masts and two funnels. There are promenade, saloon, upper, main and orlop decks, the three first named to be plated from end to end. The main deck is plated for the length of the machinery spaces, and has stringers and tie-plates beyond. Wood planking is laid on all decks. The promenade deck will remain unbroken the whole length of the vessel. Arrangements have been made in each of the vessels for carrying about 320 first-class and 200 second-class passengers and 900 emigrants. The first-class passengers will occupy the center of the vessel, the second class will be between the stern and the center, and emigrants will occupy the ends of the vessel. The main saloon, which is large enough to seat all the first-class passengers at once, will be on the upper deck forward, and will be arranged with a large dome in the middle, so that the appearance of the interior will be that of an immense hotel dining-hall. The second-class saloon will also be on the upper deck, but toward the after end, and will be fitted up in the ordinary style of a first-class saloon on an Atlantic liner. The first-class smoking-room will be on the promenade deck aft, and will be furnished with everything that experience has taught contributes to the comfort of the passengers. Besides these there will be a library and drawing-room, where the ladies and non-smokers may amuse themselves.

"So far, it will be seen there is nothing very special or peculiar about these new Atlantic ferryboats; but it is stated that the engines of the new steamers will be the most powerful quadruple-expansion marine engines in the world. They will probably develop about 10,000 I.H.P. each. The cylinders will be 36 in., 50 in., 71 in. and 100 in. respectively in diameter, with a piston stroke of 60 in., two sets of engines being placed in each vessel to turn the twin screws, which will be sectional with three blades. Steam for the working of the main engines will be furnished at about 200 lbs. pressure by six steel double-ended boilers, each 20 ft. long and 15 ft. 7¼ in. in diameter; the battery to have 48 Purves furnaces 39 in. in diameter, and to be fitted with Servé's patent tubes. The total grate surface will aggregate about 830 sq. ft., and the heating surface about 30,000 sq. ft. Piston valves will be fitted throughout, and be operated in the usual manner. The crank-shafts, eccentric straps, and connecting-rods will be of forged steel, and the piston-rods will be of ingot steel. The valve gear will be of the link type, controlled by a steam cylinder, and also by an auxiliary hand gear. The columns will be of cast steel, forked at bottom. The thrust blocks will be of the usual horseshoe type, and the thrust shafts are to be about 13 ft. long. The line shafting will be of forged steel, the bearings being of cast iron. The air pumps will be attached, but the condensers will be independent. To support the outboard shaft bearings, the hull is built out in a horizontal web to a steel frame, having both bosses cast in one piece and weighing about 68,000 lbs. The after 'deadwood' is cut away, and the keel slopes up, so that the shoe meets the boss frame at the after end. To comply with the terms of the contract, the builders will have to show, by an extended sea trial, that when working under ordinary sea-going conditions the vessels are easily capable of maintaining a speed of 20 knots per hour at sea. These quadruple-expansion engines are the most interesting feature, as they represent the first attempt to use 'quadruples' in engines of over 4,000 I.H.P.

"The vessels are so arranged as to be quickly converted into 'commerce destroyers,' and they are all American, 'no foreign materials entering into their construction' (except, perhaps, some), and they are being built by American skill and muscle (plus some that have found their way into this country). But your readers will understand that Americans are proud of these vessels; and perhaps they may be prouder still when some others that are now in 'consultation' take the ocean, and beat the White Stars and Cunarders—if they do."

The Chignecto Ship Railway.—*Transportation*, an English paper, says: "There is still hope for the Chignecto Ship Railway project. Mr. Provand, M.P. for the Blackfriars Division of Glasgow, went to Ottawa recently, with several other gentlemen interested in the matter, in order to influence the Government of the Dominion in favor of the undertaking. That the Canadian Government are in warm sympathy with the promoters has been demonstrated for years, but it was feared that repeated delays and misfortunes might have exhausted their patience. The subsidy of £34,000 per annum granted by the Dominion expired on July 31 last year, owing to the stoppage of work; and the object of Mr. Provand and his friends was to induce the Government to extend the concession. He assured the Government that the English stockholders have sufficient capital available to complete the work, and have practically entered into a contract to this end with Messrs. Pearson. They, therefore, promise that if the subsidy is continued the work will be completed within a stipulated time.

"The line, which is 17 miles in length, crosses the isthmus in a straight course from the Bay of Fundy to the Gulf of St. Lawrence, and thus saves navigators a long voyage of 600 miles around the exposed coast of Nova Scotia. The maximum grade is 1 in 500. At each terminus are docks, and hydraulic lifts have already been constructed, although not quite completely erected on the site for lifting from the bottom of these docks large gridirons, on which the vessels will be wedged up with iron chock blocks in a manner similar to that adopted at the slips at Pointhouse and other Clyde works. There are 20 hydraulic rams, 10 on each side of the narrow dock. Each ram is 25 in. in diameter, and they are forced up in cylinders by water at 1,300 lbs. pressure so as to raise the gridiron with the ship upon it a height of 40 ft. The weight of the gridiron already on the site is 1,500 tons. The ship to be lifted must not exceed 2,000 tons, the limit of size being 240 ft. long, 60 ft. wide and 16 ft. draught, and the time taken to raise the vessel is expected to be 20 minutes. The vessel will be raised to rail level. Beneath a 2,000-tons vessel there will be three 75-ft. bogies, having in all 192 solid wheels 3 ft. in diameter. Two immense American locomotives are to draw the ship over the rails. The engineers of the Forth Bridge are associated directly with the scheme."

The Panama Canal.—It is reported that a new company has been organized by French and American capitalists, and is about to begin operations to complete De Lessep's great scheme. The commissioners who were sent to the isthmus in 1890 to investigate the condition of the canal and to make an estimate of the probable cost of completing it, fixed the expense at 900,000,000 francs. In an article in the New York *Herald* it is said that:

"During the past year the subject has been taken up again. The American gentlemen connected with the management of the Panama Railroad, which is controlled by the Panama Canal Company, had Colonel A. L. Rives, the Chief Engineer of the railroad, make a careful examination of the work done and the cost of completing it. Colonel Rives finished his task, and it was submitted to the leading interests in the canal and to several institutions in Paris. It gave a new aspect to things, for it was estimated that the project could be completed with a series of six locks at a cost of 500,000,000 francs instead of 900,000,000 francs, as estimated by the French commissioners."

It is said that several French financial institutions—among them the Credit Lyonaise, Société Générale and Credit Industriale will lend their support to the new scheme.

"The original plan was to build a sea-level canal, and work was begun on it in January, 1880. As a matter of fact, the bottom of the canal was to be 10 meters below the level of the sea. But it was soon found that the excavation between Bujio and Miraflores would cost a vast amount more than they expected, so a lock waterway was decided upon in September, 1887, which reduced the cube to cubic meters to be excavated from 108,000,000 to 34,000,000, without changing the length, breadth and depth of the main portion of the waterway.

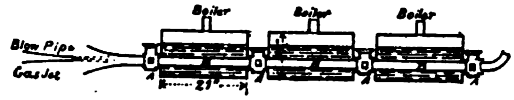
"Colonel Rives's plan is a modification of that recommended by the commissioners in 1890. It is now admitted by all expert engineers that the only solution of the problem for controlling the treacherous waters of the Chagres River is the erection of an artificial lake, between Bujio and Moraflores, 100 ft. or more above the sea level. That section of the country forms the watershed of the isthmus, and it was on the formidable Culebra Mountain, originally 370 ft. high, that much of the money was expended in excavating."

New Army Rifles.—The new army rifle which has been adopted to take the place of the Springfield rifle is 30 in. long in the barrel, with a horizontal magazine lengthwise with the barrel. This magazine contains five cartridges, and has a cut-off, so that the piece can be used as a single-shot arm and the rapid fire of the magazine held in reserve, while the firing of single shots goes on at the rate of 30 per minute. The entire arm weighs about 8 lbs., including a knife shaped bayonet. The bayonet is quite as great a departure from the old-style weapon as is the arm. The familiar three-cornered piece of steel belonging to the infantry military arms of all nations for 150 years has given way to the knife-blade form of bayonet.

But the interest in the new arm culminates in the cartridge it fires. This weighs about one-half as much as the old .45-70-405 Springfield cartridge. As the new arm is much lighter than the old, the soldier can carry 175 or even 200 rounds of the new ammunition without any increase of load beyond what the old cartridge gave when but 100 were carried. The charge of powder for the United States rifle is now 37 grains of a German smokeless explosive known as the Wetteren. Something very like it will be adopted for permanent use. This was chosen because it gave but little smoke, if any. Its burning produces a mist-like vapor, and the report is about one-half as loud as that of the service charge of black gun powder. The bullet is about an inch long, of hardened lead, with a very thin covering of nickel or steel. In order to insure to so long and slender a missile steadiness of flight over such enormous ranges, a more rapid twist in the rifle became necessary. The barrels of the new rifle have four grooves about .003 in. deep. They have one turn in about 12 in., or two and a half complete twists in 30 in. A long and slender bullet fired with the extreme velocity of 2,000 ft. per second would not take the rifling in arms with so short a twist at all, but would "strip" or jump the grooving and leave the gun nothing but a shapeless slug of lead. In order to overcome this, the hard metal coating of the bullet was necessary, as well as the increased hardening of the lead used in the projectile. The writer in the *Army and Navy Journal* who gives the above information regarding this rifle, says that there are two interesting questions that are yet to be settled. The first is, whether the bullet, with all its power, possesses the stunning effect, the "knocking-out" force, that is necessary to disable an antagonist at once. In battles with the Arabs in the Soudan the English found that they required a blow from a bullet that would knock them down. The small-bore projectile has but a small striking surface. The only test on live human beings that have been made were very recently in some small skirmishes between British infantry, armed with the new rifle, and the hill tribes along the Burmese border. In these combats the small bullets did not prove so effective as the old-time .45-caliber 480-grain missile of the Martini-Henry. Men were hit two and three times, but not immediately knocked down and prevented from fighting. A savage, be he a Zulu, an East Indian hillman, or an American Indian, must be at once disabled to prevent his doing further harm.

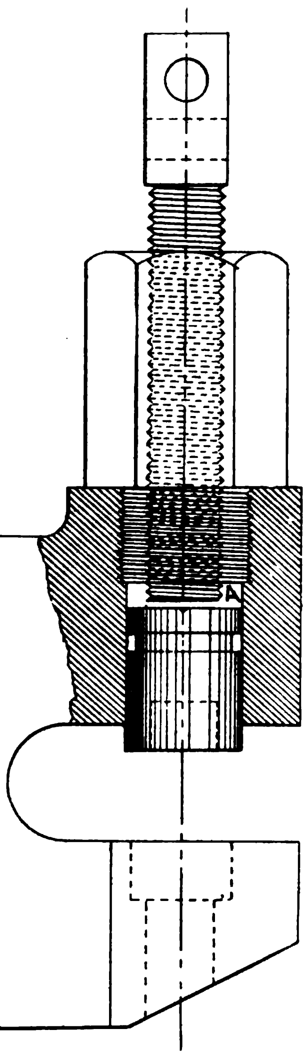
An interesting illustration of this once came under the writer's notice. In May, 1859, part of the Second United States Regiment of Cavalry (Troops A, B, C, F, G and H) fought a very sharp action with 1,500 Comanche warriors. Lieutenant Hood (afterward lieutenant-general in the Confederate Army), the adjutant of the command, went into the fight armed with a heavy ten-bore double gun loaded with a heavy charge of buckshot. He shot an Indian with both barrels at a distance of not more than 15 paces. Though terribly wounded, the savage had still power enough to shoot and wound Hood very severely with an arrow, to pin Major Thomas' chin down to his breast with another and to mortally wound an enlisted man with a third arrow before he himself died. The average white man would have been crippled beyond possible exertion by the shock of such wounds as the Indian received, but the red man still had the use of his arms, and handled his bow and heavy steel-pointed war arrows with almost deadly effect until the breath had actually gone out of him. The immediate use of this new weapon in the United States will be in the occasional Indian outbreaks that may occur from time to time.

Tests of Serve Tubes.—Some interesting experiments on the relative efficiencies of Serve and plain boiler tubes have recently been made at Barrow by Mr. Blechynden. The apparatus used is shown diagrammatically in the annexed sketch. It consists of a set of model boilers through which were placed a Serve tube and a plain tube marked *B*. The tubes of one boiler were coupled to those of the other as indicated, and Siemens' pyrometers *A A A A* were fitted at the end of each tube. A blowpipe gas jet was then caused to send its flame through one set of tubes. The pyrometer temperatures were noted, and also the evaporation effected. The boilers were 21 in. long by $7\frac{1}{2}$ in. in diameter, and were clothed with asbestos and cotton wool. The Serve tubes obtained from Messrs. J. Brown & Co. were $2\frac{1}{2}$ in. in diameter outside and $2\frac{3}{16}$ in. inside. They have seven ribs $\frac{7}{16}$ in. deep by $\frac{3}{32}$ in. mean thickness. The plain tubes were of iron, and were made by Messrs. A. & J. Stewart & Clydesdale, Limited, of Glasgow.



These were $2\frac{3}{8}$ in. in diameter outside and 2 in. inside. The mean of several experiments showed that with a temperature of 1,000° F. at the blowpipe end of the boiler, and 500° F. at the uptake end, the Serve tube transmitted 6,000 British thermal units per square foot per hour, and the plain tube 4,500 British thermal units per square foot per hour. The area measurements were made on the outside or emission surfaces of the tubes. From these experiments it would seem that the Serve ribs are very efficient heat collectors when hot gases are passed through the tubes.—*Engineering.*

Hand Boiler Punch.—In another column of this issue we publish a description of a combined screw and hydraulic press in use at Corning, N. Y. The punch which is here illustrated works upon the same principle, but needs a slight addition, in order to make it thoroughly acceptable and satisfactory. The principle upon which it works is that the hand screw is driven down into the chamber *A*, which is filled with grease, causing a certain pressure per square inch to be exerted upon it; this pressure is transferred to the end of the punch, which is larger



COMBINED SCREW AND HYDRAULIC PUNCH.

on the screw end, and therefore subjected to a greater pressure than that exerted by the screw itself. It will be seen that the screw is very long; and when it is new and well fitted not much trouble is caused by the grease working back up the threads, but as soon as it becomes worn leakage occurs, and the efficiency of the punch is correspondingly diminished. If this were arranged with the packing by the screw it would be a very valuable little tool for punching through moderate thicknesses of metal, for which nothing but hand power is available.

The Failure of Torpedo-Boats in the Manœuvres of the British Fleet.—A correspondent of the London *Times*, who described the recent manœuvres of the fleet, comments as follows on the effectiveness or, rather, non-effectiveness of the torpedo-boats:

"A subsidiary feature of the manœuvres, of no little interest in itself, is the total failure of the torpedo-boats on either side to put in an effective appearance or in any way to hamper the movements of their adversaries. This is, of course, partly due to the fact that, owing to the premature conclusion of the manœuvres, they had only a single night in which to operate. The C Blue fleet was not attacked at all, but the D Blue fleet was attacked early in the night, apparently without success. All this is most instructive. The night, though fairly clear, was very dark. A ship without lights could hardly have been seen at all from the deck of a torpedo-boat at a distance of more than 300 yards. Admiral FitzRoy apparently proceeded altogether without lights. In these circumstances it is plain that the Blue torpedo-boats could only come across him by the merest accident. No skill or vigilance on their part could enable them to do it. The conditions in the neighborhood of Belfast were a little more favorable to the Red torpedo-boats stationed there, because the channel is narrower and the Blue fleets used their navigation lights. But even here the chances were all against the torpedo-boats, which not only had to find the ships to be attacked, but to fire their torpedoes before they had themselves been under fire for 30 rounds from the ships. It has been proved experimentally that more than 30 rounds can be fired from a ship in the very brief interval which elapses between the discharge of the torpedo and the moment it strikes the ship. Hence, in the most favorable circumstances a torpedo-boat has very little chance indeed under the rules laid down for the manœuvres. But, without further insisting on this point, which is a point of manœuvre practice not quite analogous to the conditions of actual warfare, I would point out that the proper tactics of torpedo-boat attack seem as yet to have been very insufficiently studied. For the reasons I have given the chances of a torpedo-boat finding the ship or fleet it desires to attack appear in practice to be so small, except in the case of a ship or fleet known to be at anchor in a known position, as to make the success of the torpedo-boat a matter of the merest accident. A moonlight night, which increases the chances of a torpedo-boat, also increases the defensive power of the ship in a measure proportional to the wider horizon commanded by the latter. Hence it is the opinion of many of the most experienced torpedo officers that a division of torpedo-boats must be provided at its station with a cruiser which can scout for the enemy and give the torpedo-boats direct information of the position he occupied and the course he was steering at nightfall. In that case it becomes comparatively easy for the torpedo-boat to find the enemy; in any other case the whole proceeding reduces itself to a game of blind man's buff, in which it is the torpedo-boat that is blindfolded. A most instructive and significant illustration of the foregoing principles was afforded on the night of Saturday. The Blue torpedo-boats failed entirely to find Admiral FitzRoy's fleet. The Red torpedo-boats found Admiral Drummond's fleet, but failed to attack it successfully—for what reason I have not been fully informed. But one division of the Blue torpedo-boats—the Queenstown division, which was transferred to Kingstown—met us on Saturday evening off the Kish Bank. Its leader was informed by the admiral that three cruisers, presumably belonging to Admiral Dale's fleet, had been seen from the signal station at Blacksod Bay at an early hour in the morning, and might therefore be expected to be in the neighborhood of Belfast during the night. Here was a case in which the torpedo-boats had a definite object to look for and a definite place in which to look for it. They found three cruisers under the Mull of Galloway, and, not receiving or failing to understand the private signal, they forthwith proceeded to attack them. Unfortunately, the three cruisers in question turned out to be the *Warspite*, *Australia* and *Galatea*, belonging to Admiral Drummond's fleet, and though no ship was torpedoed, two out of the three torpedo-boats were put out of action, the third having previously gone astray. Two points are here to be noted—one that the torpedo-boats were operating, not at random, but in pursuit of a definite object—namely, three enemy's ships, whose probable position and course were approximately indicated to them beforehand; the other that, after all, the object they found was not the object they sought, but three friendly ships, whose destruction, had it been accomplished, would have inflicted irreparable loss on their own side. This very awkward habit of mistaking a friend for a foe is one which has often before been exhibited in manœuvres by torpedo-boats. It is less likely to occur in actual warfare, because nearly all foreign ships differ very widely in external appearance from any of our own; but its occurrence is regarded by many authorities as sufficiently probable to require that English torpedo-boats should always make the private signal before proceeding to extremities. This means, of course, that English torpedo-boats will never be able to attack except under the most unfavorable conditions—conditions so unfavorable, indeed, as almost to insure their destruction. But those who take this view regard it as a logical deduction from Lord George Hamilton's dictum that the torpedo-boat is essentially the weapon of the weaker combatant. So regarding it, they also regard the almost certain destruction of an English torpedo-boat by an enemy as of less moment to England than the possible destruction of an English battleship by a friend; and they consider that the best way to avert such a catastrophe as the latter is to require the torpedo-boat to declare itself by making the private signal in all cases which

leave room for more than a shadow of doubt. These views are new to me, as they will be to many of your readers, who will perhaps be not a little surprised to learn that they are held by professed advocates of torpedo-boats. They seem to place the strategic value of the torpedo-boat for English purposes even lower than some of its most severe critics have ever ventured to place it; and it is certainly not a little remarkable that they should be entertained at a time when some high authorities are beginning to doubt whether the position even of the battleship in the naval warfare of the future is not beginning to be imperilled by the development of vessels of the *Havock* and *Hornet* class, regarded as sea-keeping torpedo-boats, which might in favorable circumstances attack even in the daytime, or having found their enemy in the daytime, might hover round out of range and attack in large numbers after dark."

Buffington-Crozier 10-in. Disappearing Gun Carriage.—Our readers will remember that in February of this year we published a very complete description, with drawings, of the 8-in. disappearing gun carriage of the Buffington type designed by Captain William Crozier. The work which was done by this carriage was so successful that an order was at once issued for the construction of a second carriage to carry a 10-in. gun; this has now been completed, tested and accepted. The appearance of the two carriages is so nearly alike that a photograph of one might easily be passed off for a photograph of the other, with the exception, of course, that the 10-in. carriage is very much heavier than the 8-in. But even with this additional weight the lightness of the construction is such that it hardly seems possible that it can withstand the strains which are necessarily engendered by the fire of a 10-in. gun. For the sake of a comparison between the two, we recapitulate some of the dimensions and weights of the 10-in. carriage, giving the corresponding dimensions for the 10-in. carriage. Each chassis casting for the 8-in. carriage weighs 14,000 lbs., and that of the 10-in. 23,000 lbs.; the weight of the 8-in. gun is 33,000 lbs., that of the 10-in. 67,000 lbs.; the counterweight for the 8-in. is 37,000 lbs., that for the 10-in. 67,000 lbs. The limits for elevation and depression for the 10-in. gun is 15° elevation and 5° depression, which is exactly the same as that of the 8-in. gun, and this extreme arc can be swept through in 25 seconds. The diameter of the hydraulic cylinders is 11 in. The total weight of the carriage, exclusive of the counterweight, is 66 tons. On the rapidity tests 10 rounds were fired in 14 minutes and 42 seconds; in all 68 rounds have been fired from the gun. The time required for the gun to rise from the loading to the firing position is 11¼ seconds; but no record has been made of the time during which the piece remains above the parapet, but the probabilities are that it is in the neighborhood of 5 seconds. As the piece is aimed before the rise, it can readily be seen that in this 5-second interval it would be impossible for an enemy to fire a shot and strike the gun at a distance of 2 miles, provided their guns were trained and the lanyard pulled at the moment of the appearance of the muzzle above the parapet. Before leaving this subject we wish to refer to a few of the details of the mechanism. The gun is trained by hand, the pinions on the crank shaft being 4 in. in diameter and meshing in with a spur wheel in the ratio of 11 to 60. On the shaft of the spur gear there is a worm driving a worm wheel, upon whose shaft there is a chain wheel over which the chain is rolled, the ends being fastened outside of the travel; thus the carriage is trained by winding this chain over the wheel. Hand gearing is also used for elevating and depressing the gun. A tiller wheel takes the place of a crank, and on its shaft there is a pinion which meshes in with a spur wheel, on whose shaft there is a pinion that in turn meshes in with a rack on the link block at the lower end of the breech levers, that serves to elevate and depress the ends of these bars. When the first 10-in. carriage was designed, the guides for the recoil cylinders were made horizontal, but owing to the great weight of the gun inclined ways were afterward put on with an inclination to assist in checking the recoil. But the smooth working of the carriage has demonstrated that this provision was unnecessary, and hereafter they will be made horizontal, as in the first design, and as was used on the 8-in. carriage. The gun which is mounted on this carriage is an experimental gun designed by Captain Crozier, of the wire-wound type. Of the 68 rounds fired, nearly all have been with full charges, giving pressures of about 42,000 lbs. per square inch; the highest pressure thus far obtained has been 46,000 lbs. The test of the carriage has been finished and the work accepted, but that of the gun will be continued. Owing to the fact that the traversing circle is not well set and is of a temporary character, no satisfactory results have been obtained for the time required for training. In a future issue we hope to publish a detailed description of this wire-wound gun.

EIGHT-WHEELED PASSENGER LOCOMOTIVES FOR THE BOSTON & ALBANY RAILROAD.

The Schenectady Locomotive Works have recently completed two eight-wheeled locomotives for express passenger service on the Boston & Albany Railroad. The particular work for which these engines are designed is that of hauling the Boston & Chicago special limited train, consisting of six vestibule Wagner cars, over the mountains between Albany, N. Y., and Springfield, Mass. The limitations placed on the builders were that the weight on the driving-wheels should not exceed 74,000 lbs. The time is quite fast, being 183 minutes for a run of 103 miles, making one stop. It must be taken into consideration also that the grades on this division are quite heavy, there being a continuous grade going east of about 80 ft. to the mile for 8 miles; to the summit it is still heavier for 12 miles going west, and no pushers are allowed on these grades. In addition to these two points there is quite a stiff ascending grade over the balance of the road toward the summit from the Hudson River running east and from the Connecticut running west. The reference to the table of dimensions, which is published below, will show that the heating surface is 1844.7 sq. ft., which is probably as great an amount as has ever been applied on the engines of this weight. In order to reduce the weights to the minimum gun iron has been very extensively used in place of cast iron, especially in the driving boxes, the eccentrics and straps, pistons, etc. The particular metal that is used has a tensile strength of 30,000 lbs. per square inch. With reference to the use of this metal the following data will be of interest regarding the weights which were obtained, showing the light weight of the revolving and reciprocating parts, it being borne in mind that the cylinders are 19 in. in diameter, and that the boiler pressure is 180 lbs. to the square inch. The piston of gun iron in T form, with the rod 3¼ in. in diameter, weighs 304 lbs. The cross-head, with 18-in. wings in top guides, 4 in. wide, with a 3¼ in. × 4-in. pin, weighs 202 lbs. The main rod of I section weighs 422 lbs.; side rod of I section, 246 lbs.; main crank pin, steel, hollow, 110 lbs.; back crank, steel, 104 lbs. Of course this reduces the counterbalance required to a minimum; and it is expected that the hammer blow will be materially lessened over that which is ordinarily produced. The use of a hollow crank-pin, we believe, is a novelty in locomotive practice, although it has been in use for many years on marine engines. It will also be interesting to note the effect of the increased steam pressure and the economy on these single expansion engines, as it has about touched the limit of that which has been set for economical practice in compound work.

Following are the general dimensions of these engines:

GENERAL DIMENSIONS.

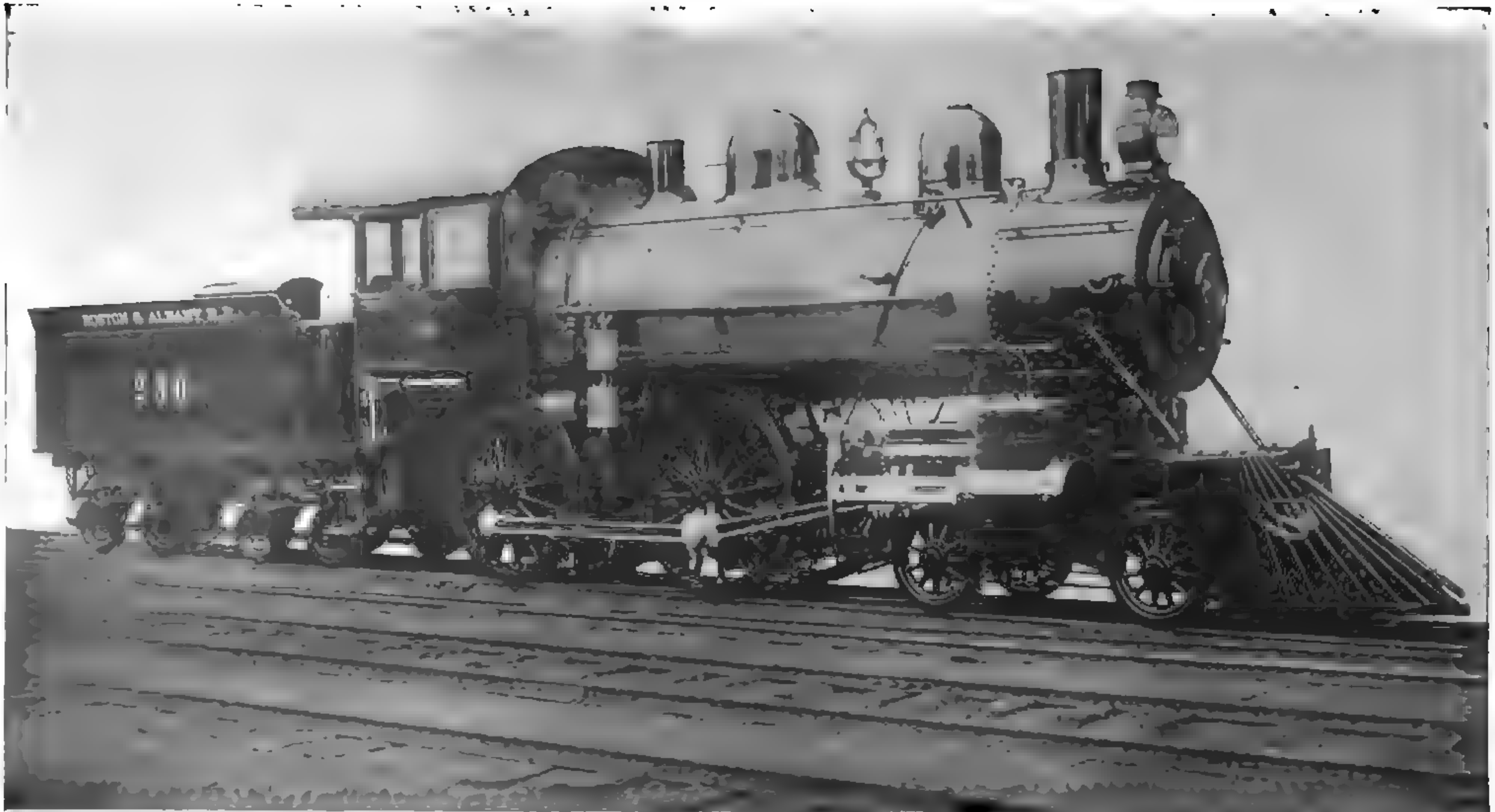
Fuel	Bituminous coal.
Gauge of road	4′ 8½″
Weight of engine in working order	114,700 lbs.
" on drivers	74,000 "
Wheel base, driving	8′ 6″
" " rigid	8′ 6″
" " total	23′ 11″

CYLINDERS AND VALVES.

Diameter of cylinders	19″
Stroke of piston	24″
Horizontal thickness of piston	4¾″ at rim. 5¾″ " hub.
Kind of piston packing	Cast-iron rings.
" " rod packing	U. S. Metallic.
Diameter of piston rod	3½″
Size of steam ports	18″ long × 1¼″ wide.
" " exhaust ports	18″ long × 2¾″ wide.
" " bridges	1⅛″ wide.
Greatest travel of slide valves	5½″
Outside lap " " "	⅞″
Inside " " " "	0″ line and line.
Lead of valves, in full stroke	1/16″
Kind of slide valves	Richardson balanced.
" " " " steam packing	U. S. Metallic.

WHEELS, ETC.

Diameter of driving wheels outside of tire	69″
Tire held by	Shrinkage and retaining rings
Diameter and length of driving journals	8″ × 11″
" of engine truck wheels	33″
" and length of main crank-pin journal	5½″ × 5½″
" " " " side rod " "	4½″ × 3½″
Driving box, material	Gun iron.
Engine truck wheels	Snow boltless, steel tired.
Driving springs	Hung underneath the driving-boxes
" " centers	42″



EIGHT-WHEELED PASSENGER LOCOMOTIVE, BUILT FOR THE BOSTON & ALBANY RAILROAD BY THE SCHENECTADY LOCOMOTIVE WORKS.

BOILER.

Style	Extended wagon top.
Outside diameter of first ring	60"
Working pressure	190 lbs. per sq. in.
Material of barrel and outside of fire-box	Carbon steel.
Thickness of plates in barrel and outside of fire-box	$\frac{9}{16}$" and $\frac{5}{8}$, $\frac{7}{16}$, $\frac{1}{2}$.
Horizontal seams	Butt jointed, with welt strip inside and outside.
Circumferential seams	Double riveted.
Fire-box, length	$90\frac{3}{16}$"
" width	$40\frac{5}{8}$"
" depth	F. $71\frac{3}{4}$", B. $59\frac{3}{4}$"
" material	Shoenberger.
" thickness	Crown $\frac{3}{8}$", tube $\frac{1}{2}$", sides and back, $\frac{5}{16}$"
" water space	Front 4", sides $3\frac{1}{2}$", back 8"
" crown staying	1" radial stay-bolts
" stay-bolts	Taylor iron.
Tubes, material	Charcoal iron, No. 13 W. G.
" number of	298
" diameter	2"
" length over tube sheets	11'
Heating surface, tubes	1,703.8 sq. ft.
" " fire-box	141.4 "
" " total	1,844.7 "
Grate "	25.29 "
" style	Rocking, worked in 2 sections.
Ash pan, style	Sectional, with dampers F. & B
Exhaust pipes	Double.
" nozzles	$3\frac{1}{4}$" & $3\frac{3}{8}$" diam.
Throttle	Balanced valve, double poppet.
Smokestack, 1 D	14" at center. 16" " top.
" top above rail	14' $1\frac{1}{2}$ "

Boiler supplied by 2 No. 10 Mack injectors placed right and left.

TENDER.

Weight empty	37,200 lbs.
Wheels, number of	8
" diameter	36"
Journals, " and length	$4\frac{1}{2}$" × 8"
Wheel base of tender	14' 2"
Tender frame	7" × $3\frac{1}{2}$" ×1" angle iron.
" trucks	Side bearing, wood bolster.
Water capacity	4,000 galls.
Coal "	8 tons.
Total wheel base of engine and tender	45' 11"
" length of engine and tender	55' $7\frac{1}{2}$"

Engine fitted with Westinghouse-American combined air brake on front side of all drivers, on tender and for train.

Martin's steam car-heating apparatus.

AMONG THE SHOPS.

AT CORNING, N. Y.

IT is a rarity in these days of rapid railroad development to find a shop that is fully up in size and appointments to the needs of the road which it is serving. The machine shop is a necessity from the very start; but as the public are not clamorous for larger buildings and more lathes, and as the daily press would be utterly lost in an attempt at reform on these premises, the machine shop is usually called upon to work to the utmost of its capacity in order to maintain repairs and keep the rolling stock in order. The shops of the Fall Brook Coal Company, at Corning, N. Y., are of this class, and the amount of work put through them calls for the economizing of time and space to the last degree. The housing capacity of the shop consists of three pits holding one engine each and three pits capable of accommodating three engines each. With this capacity 76 regular road engines are cared for in addition to five mining engines and a number of engines used on logging roads. No transfer table is used, as the tracks lead directly into the pits from the yard.

If we are not mistaken, Mr. William A. Foster, the Superintendent of Motive Power of the road, was one of the pioneers in the use of hydraulics and compressed air for hoists in and about his shops. Corning lies on a side hill forming the southern boundary of the Chemung Valley. On this hill the reservoir of the city water-works is situated at a height that puts a pressure of 90 lbs. per square inch in the mains at the low level of the shop. It was, therefore, an easy and simple matter to connect the water pipes with hoists and avoid the necessity of using muscle for the heavy work about the shop and yard. The first application was made to a hoist used for loading and unloading car wheels, and consisted of a simple cylinder, like those illustrated for the use of air in the AMERICAN ENGINEER for January of the current year. The cylinder is hung from a trolley traveling over a rail running across the track, and the connection is made by a rubber hose. This apparatus lifts the wheel from the car and lowers it to the platform, where it is rolled to the storage place. The saving effected in the handling of wheels by this hoist naturally led to the construction of others, until now the whole shop is pretty thoroughly equipped.

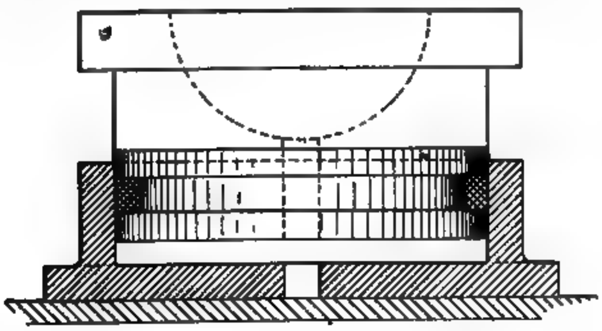
Among the interesting application of hydraulics is the wheel pit, where driving-wheels are removed from and placed under locomotives. The pit is somewhat deeper than the usual repair pit, and near its center a hydraulic jack or hoist is located, the cylinder being buried in the ground and the ram having a length sufficient to lift a pair of drivers from a point where they are below and clear of the rails up to their proper position under the locomotive. The pit widens out abreast of the ram for a space of about 6 ft., causing a break in the line of rails. This break is bridged by loose rails slipped into position and held by wedges after the wheels are up and upon which they are run out. Outside of the main tracks there is another line of rails, upon which a lorrie car of broad gauge is run that is used for carrying the tail of the locomotive when the drivers are removed. The method of operating in putting the drivers under a locomotive—say a mogul—is to back the engine into the shop and block the back end up on lorrie just referred to. The front pair of driving-wheels is then rolled upon the rails spanning the break in the track and lifted clear by the hydraulic jack. The movable rails are then taken out and the wheels lowered into the pit. The engine is then backed over the space till the front pedestals are in the proper place and the wheels raised, with the axle boxes adjusted, to position. The movable rails are then replaced, the engine pulled out, and the process repeated for the other two pairs of wheels. Up to this time the lorrie has carried all the weight of the tail of the engine; but as it is pulled out of the shop, the work having been completed, the lorrie runs down an incline on its special track, lowers the engine upon its own wheels, frees its blocking, and the work is done. The time required to put three pairs of driving-wheels under a mogul locomotive with this apparatus, counting from the rolling of the first pair of drivers upon the movable rails, is 20 minutes. Five or six men, with a locomotive to do the shifting, perform the work.

Since hydraulic lifting has shown itself to be so convenient, pneumatic lifting has been introduced where it is inconvenient to dispose of the waste water of hydraulic apparatus. All of the hoists used in and about the shops are home-made, but the designs are necessarily so similar to what might be called standard types that we do not reproduce any of them in our engravings.

In the car shops there are a number of hydraulic lifts that are used for jacking up cars, and which are operated in a manner very similar to the hydraulic tubs in use in the shops of the Delaware & Hudson Canal Company, as illustrated in the AMERICAN ENGINEER for December, 1893. The usual size for these lifts is 10 in. in diameter and a stroke of about 14 in. They are made of cast iron, and have two handles on the top head for convenience in carrying. Just outside the car shed there is a gallows frame straddling two tracks and carrying two suspended lifts that can be used for lifting any car, passenger or freight, from its tracks. One of the pits of the round-house is also equipped with hydraulic lifts. There are six cylinders arranged in pairs, each having a diameter of 18 in. and a stroke of 24 in. They are disposed two at each end of the pit and two at a point near the tail of the locomotive. They are exceedingly handy for those round-house repairs that require the locomotive or tender to be lifted from the tracks or the springs to be relieved of the weights which they carry. It is somewhat of a novelty to find hydraulic lifts in round-house pits, but it is a novelty that takes the form of a very handy wrinkle. The round-house itself has 24 stalls. It is built in two sections, with entrances between the two parts. The floor is neatly paved with brick, and the whole building is heated by steam pipes running around the outer wall and fed by a boiler in the round-house.

In the article descriptive of the shops of the New York, Lake Erie & Western Railroad, published in our last issue, we mentioned the adaptation of an old steam pump to the purposes of small tool driving. The same thing has been done here with results equally satisfactory. The little engine drives drills and valve-facing tools directly by means of the Stow flexible shaft. The same practise also prevails here, as on the other road, in the construction of pistons. A hollow piston with rings sprung in is used, but the rings are much narrower than on the New York, Lake Erie & Western. Mr. Foster uses a ring only $\frac{3}{8}$ in. wide, and finds them perfectly satisfactory. There is a method of holding the split rings out

here, however, that—to us at least—is novel. It is well known that if a ring is turned to a larger diameter than that of the cylinder in which it is to run, when it is sprung in it will be out of round. To obviate this difficulty and, at the same time, keep an outward pressure on the ring, it is turned to fit the cylinder. Another and slightly heavier ring is turned to a diameter a trifle larger than the inside of the outer ring, and the outer ring slipped over it. Then, when they are both compressed and put in the cylinder, the outer ring is round, while the inner keeps it well out against the walls.



BALANCED VALVE, FALL BROOK COAL CO.

The car shops adjoin the machine shop, and are fitted with the usual complement of wood-working tools. The floor room consists of three tracks, each capable of holding five cars. All cars coming in for rebuilding and all new rolling stock are equipped with the Gould coupler and the Westinghouse air brake.

The nicknames bestowed upon various types of locomotives by the men building or running them have come to have a truly technical significance; but it is seldom that a nickname is accepted by the motive power department with the gravity of a name applied to one of the locomotives on this road. All the engines have names as well as numbers, though the former are a mere ornament and not used in reports or orders. A certain locomotive had the misfortune to jump from a high trestle at Ithaca, and was forthwith dubbed the *Sam Patch* by the men. Repairs naturally followed the leap, and when the machine emerged from the shop, behold, it had been duly and officially christened the *Sam Patch*, and the name is on the panel of the cab.

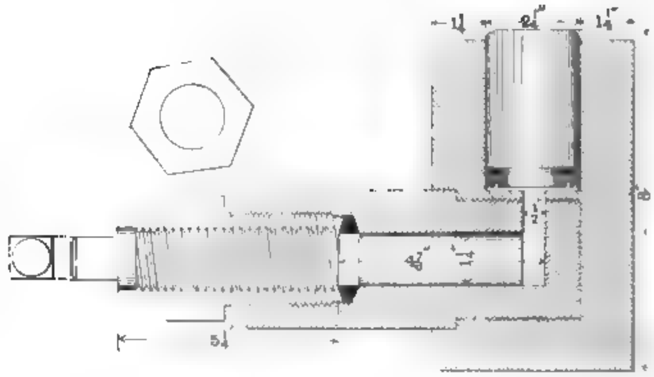
Of course in a shop like this there are the wrinkles that grow up from the necessities that arise from time to time. Among those to be found at Corning we illustrate a few. One of these is a

BALANCED VALVE.

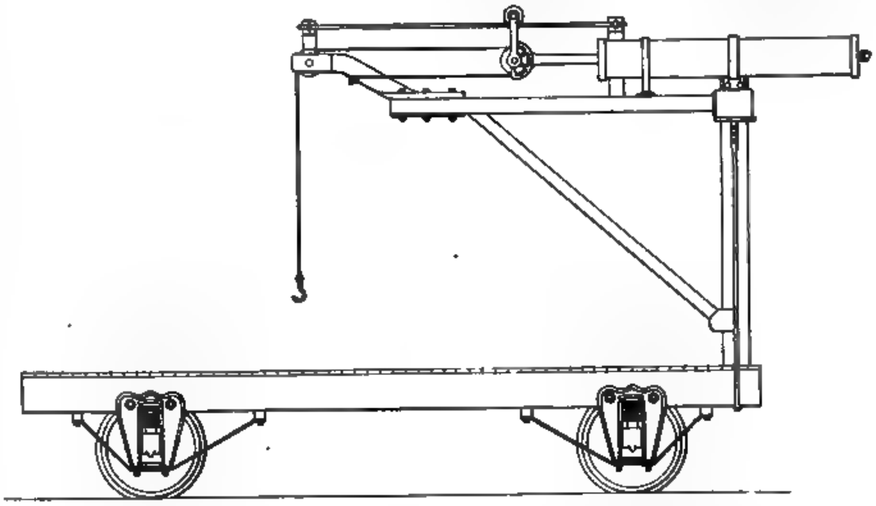
The design of this valve presents no new features, as the same principle has been applied to work on stationary and marine engines; but we have not seen it arranged for use on locomotives before. The body of the valve where the yoke has a bearing is somewhat wider than usual, and the upper portion is round, as indicated by the shading. The cap rests over this cylindrical portion, and a steam tight connection is made by the packing rings shown by the double hatch cross sectioning. The cap has a bearing against the inside of the steam-chest cover, traveling, of course, with the valve. The usual provision for leakage is made over the *D*, and is indicated by the dotted lines. In our issue for July, 1893, we illustrated the balanced valve in use on the locomotives of the Delaware & Hudson Canal Company, where a circular packing was used; but in that instance two circles were used instead of one.

HYDRAULIC SCREW PRESS.

The attempt to make a combination of a screw and a hydraulic ram is old, but many of the earlier designs for the increase of power by this union were ineffectual and unsatisfactory owing to leakages past the screw. The Corning shops have, however, several tools in which this principle has been successfully applied; one of them being illustrated in the press shown in our engraving. The particular work for which this tool was designed is the pressing out of jaw bolts, straightening frames and other work of a similar character. The construction is very clearly shown by the engraving. The screw is prolonged beyond the thread to form a ram having a diameter of 1¼ in., which is forced down into a chamber at the base that is filled with grease which is in turn crowded against the larger ram of 2¼ in. in diameter, forcing it out against the work. It will be noticed that there is a packing about the small ram to prevent the grease from flowing back into the threads. It is absolutely necessary that this should be used, and also that the grease should not be too thick, for if it is air will collect in the interstices and so cushion the motion of the small ram that the work will be unsatisfactory. In another column we publish an engraving of a hand punch designed on the same principle.



COMBINED SCREW AND HYDRAULIC JACK.



CRANE CAR WITH AIR HOIST, ON THE FALL BROOK COAL CO.'S RAILROAD.

CAR WITH AIR-HOIST CRANE.

Air has come to be recognized as such an important factor in the economical handling of material that new applications are constantly springing up. One of the most interesting that has lately been brought to our attention is a derrick car designed by Mr. Foster, and used about the Corning yards for handling and transferring all sorts of material. Our engraving is not mechanically correct, as it is drawn from a pencil sketch, but it does give a fair idea of the general appearance of the car. A four-wheeled flat car of about 25 ft. in length carries at one end a jib crane, on the summit of whose post an air cylinder about 8 in. in diameter and a piston stroke of about 6 ft. is mounted. The outer end of the piston-rod is attached directly to a sheave, the weight of which is carried by a stirrup and pulley, the latter running on an overhead rail, as shown. A wire rope with one end made fast at the outer end

of the boom is rove through this sheave, and, passing over an idler, is made fast to a hoisting hook. The post is more thoroughly braced than the drawing would indicate, as the main brace leading from the left-hand end of the car to the cap beneath the cylinder is omitted entirely. Air is supplied to this car from the train pipe of the engine that is used for moving it about. No difficulty is ever experienced in this particular, for there is always an idle engine in the round-house that can be utilized, and the attendance of an engineer and fireman are not required, as the work is usually done at some one point, so that it is merely necessary to keep a fire burning sufficiently active to maintain steam pressure for the air pumps, while the round-house hostler can move the engine from point to point as the work to be done demands. The car is especially useful for unloading lumber, for loading and unloading car wheels at points removed from the regular hoists, and, like other handy appliances, new ways are continually springing up in which the car is put into service. With a locomotive to provide the air, one man can work this crane for a day without fatigue, while the pull on the cranks of an ordinary derrick will soon tire two able-bodied laborers.

THE CAR SHOPS OF THE LEHIGH VALLEY RAILROAD AT PACKERTON, PA.

AT PACKERTON, PA.

The main car shops of the Lehigh Valley Railroad, in charge of Mr. John S. Lentz, are located at Packerton, Pa., on the banks of the Lehigh River. The illustration which we give shows the shops as they appear from a hill opposite the round-house that is not seen in the engraving. It will be noted that the yard and shops occupy the whole of the bottom land extending from the foot of the steep hill to the river side, and that the stream flows close in to the opposite or northern hill. The buildings are all of brick or stone, substantially built, and remarkably well arranged for economical working.

East of the shops, and extending for a long distance beyond what is the extreme right of the engraving, is a lumber yard, in which several million feet of lumber are stored. Formerly it was the policy of the company to keep about 8,000,000 ft. in stock; but now there is considerably less—probably not more than 3,500,000 ft. The question has arisen as to whether it is profitable to lock up as much money as is required to carry even so large a stock as that now on hand. If every stick that went into a car was sure of remaining there until it had rotted away, there is no doubt but that it would prove economical to use nothing but the best of air-dried lumber; but when it is taken into consideration that a very small percentage of car lumber is thus worn out, and that almost all of it is eventually broken up by accidents of a more or less serious character, railroad managers are of the opinion that green timber is cheaper to smash than air-dried lumber, that has been increasing in value through an accumulation of interest for several years.

There is one industry connected with the old car timbers of the Lehigh Valley that we have not met on other roads. All of the charcoal used on the system is burned at Packerton from old material that has been taken from wrecked or worn-out cars. By this it is not meant that *all* of the old material is so burned, but merely enough to supply the demands of the service, which ranges from 2,500 to 3,000 bushels annually. The kiln is located in the yard, just below the shop, and, except when in use, consists of a vacant space, as the old-fashioned earth-covered type of built-up kiln is used, and this vanishes when broken into for removing the coal.

At the upper end of the yard there is an isolated building containing a tank of about 75 barrels' capacity, from which pipes are led to three hydrants near a repair track running parallel to the main line and beyond the buildings. This tank is for kerosene that is carried by the piping to the hydrants, from which it is drawn into the tanks of the Eastman heater cars, each having a capacity of about one barrel. As the cars of the road are built to certain adopted standards, it is possible to keep a large stock of duplicate parts on hand for repairs, thus very materially lessening the cost of those repairs. In fact, it has been found that, taking an end sill for an example, it costs as much to do the work on one for a foreign car that is of an odd size as it does on a dozen or fifteen of the home cars when the latter are made up in quantities. The machinery, too, in the main shop has been arranged with special reference to the rapid and economical execution of work that is in duplicate and in quantities. The facilities are such that when a stick of timber starts it is kept moving until all the labor that is to be put upon it is done. Near the eastern entrance, on the side toward the lumber yard, there is a large cutting-off saw, where all the stuff that is brought in is cut to the proper length. From this saw it is carried by a gang of laborers to a surfacing planer that dresses the four sides at once. Here it is loaded upon lorrie cars and sent ahead a few feet to the man who does the laying out. The tenoning and boring machines for the long sills are so arranged that two men can take a stick through them, or, when the work is pushing, the men operating one machine pass their products on to the next, and thus it is kept moving until it is finished. The same arrangement obtains for the shorter timbers; and as this work is all done by the piece, there is no lost time and the machines are not allowed to lie idle by the men.

In speaking of the utilization of a portion of the old car material for charcoal, it should have been mentioned in the same connection that a considerable portion of it is also utilized for ties for sidings and for fence posts.

Just east of the main shop there is an extension connected with it by three transfer cars that are under shelter. These are operated by hand power by means of a ratchet attached to a long lever and working on one of the axles. This extension is mainly used for repairs, and is provided with scaffolding between the tracks with a narrow-gauge track beneath for the transportation of material. The main track, running down through the shop, connects by way of the transfer tables with the tracks in the extension, which in turn have direct connections with the yard tracks. The main shop track is broken by a number of turntables, by which it is connected to cross lines where the short, four-wheeled coal cars are repaired. These latter are, however, slowly disappearing from among the rest of the rolling stock. A limit of $12 has been placed on the repairs that can be put upon them; and when one comes in that will require more than this it is broken up.

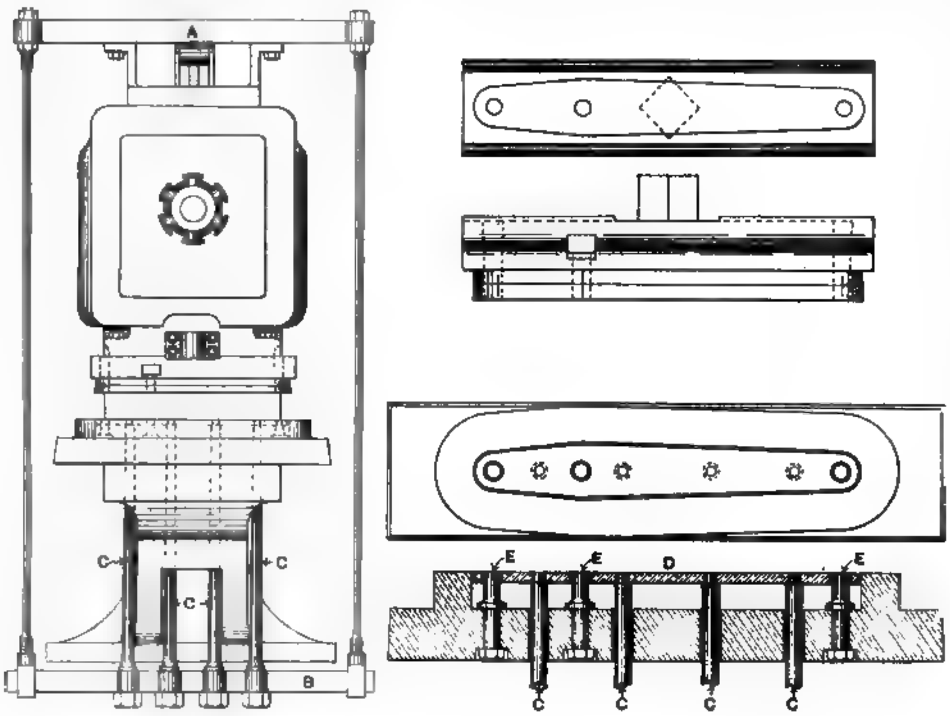
The operation is very simple. As the head comes down, the stripping plate drops into the die and the lever is cut and punched to shape and finish; then, as the head rises, the stripping plate lifts the lever off the punches *E E E* and clears it of the machine.

Power is carried from one end of the machine shop down to the lower end of the blacksmith shop by a wire rope, the distance being about 375 ft., with two sets of carrier pulleys intervening. This transmission works with remarkable smoothness and with no whipping of the rope, showing what can readily be accomplished in this direction if suitable care is taken to have the wheels true on the outside and running true in their bearings. Old bolts receive very little attention in the ordinary shop, and the path from the boneyard to the scrap pile is usually very direct; but here it has been found to be economical to sort and straighten old bolts, recutting the threads where required; and for this purpose a gang of laborers are kept busy in spare moments doing this work in a shed alongside the blacksmith shop.

A new type of mile and signal post is now being made from old boiler tubes. The tubes are split at one end and a round disk set in the slot, rivetted fast and painted white. For ringing and whistling posts the disk is square, set in with one corner down. These will be more durable than wooden posts, besides being cheaper in first cost, as they are made entirely of waste material that is worth only the price of scrap.

As the iron-working machinery of a car shop is of the simplest description, we do not expect the elaborate tools found in the locomotive works, but among the tools at Packerton there is a number of bolt cutters that were made on the premises which are holding their own with those of outside manufacturers. There are 14 of these tools in all, in addition to two gang nut-tapping machines.

Steam is generated for these shops by three return tubular boilers, two of which are fired with coal and one by shavings blown in from the shop to a fuel room and carried thence to the furnace by a steam jet. A double engine of about 150 H.P. drives all the tools and shafting.



LONG'S IMPROVED PUNCHING PRESS.

Running, as the road does, through the peach district of New Jersey, it is called upon to transport large quantities of this fruit during the season. This traffic is accommodated by transforming a number of box cars into fruit cars by the removal of the ordinary door and the substitution of a ventilated door therefor, and by placing portable shelves on iron racks in the interior. In the fall, when the season is ended, these doors and racks are removed and the cars are re-equipped with the ordinary closed doors.

North of and parallel with the wood-working shop is the blacksmith and machine shop. Entering the former, at the eastern end, there is nothing of the usual disagreeable sensations experienced that are due to the sulphurous gases arising from the use of soft coal, as anthracite is used in nearly every furnace. At this lower end of the shop there is a closed furnace for heating metal, and near it a heavy punch, with which the brake levers and other similar parts are punched ready for application to the cars. The special features of this punch by which the work is done was designed by Mr. James Long, the foreman of the machine shop. It is shown very clearly in our illustration. To the top of the punch head the cross bar *A* is bolted, and from this two rods drop down on either side to a lower cross bar, *B*, to which the pins *C C C C* are fastened. These pins run up through the frame and carry the stripping-plate *D* that rises and falls with the punch head. The dies are fitted to cut the hot bar to the exact shape of the lever, and in the bottom the punches *E E E* are fastened that punch the holes for the connections. The punch is, of course, fitted with suitable matrices to receive the small punches and buttons.

Just outside the engine-room there is a space that is covered with a flooring as hard and smooth as a piece of glass. Few would guess that it was formed by the rusting down of the dust from the wheel-grinding machine, a mixture of emery and cast iron; but it is, and it is as far ahead of any other iron rust floor as can possibly be imagined. It will naturally be inferred from the fact that there is a sufficient quantity of this dust to make a floor, that the practise of grinding wheels prevails, and such is the case. New wheels are not touched, but old wheels with flat spots that are otherwise serviceable are ground, and are giving fully as much mileage as a new wheel, the flange being left untouched.

One of the most interesting things about Packerton is the scale used for weighing coal. All of the coal that passes over the road, with the exception of that handled by Coxe Brothers, is weighed at this point. The scale platform is 123 ft. long, with the scale house so arranged that the operators, three in number, have a clear view up the track. Cars loaded with coal are sent down the track either singly or coupled in twos and threes. While they are passing over the scales one man balances them and calls off the gross weight; a second reads, notes and calls off the tare, while the third takes the figures given and reports the net weight. Sometimes the work is light, but frequently the shipments are very heavy, calling for a corresponding speed of weighing. One day in September, for example, more than 25,000 tons were weighed on these scales, and this has to be done while cars running from 12 to 15 miles an hour are passing over a distance of from 60 ft. to 65 ft.

CENTRIFUGAL PUMPS.*

By John Richards.

(Continued from page 465.)

To give some idea of the extent of centrifugal pumping in Europe, there is given below a list of some of the largest plants made, by two firms only, previous to 1892.

Where Erected.	Name and Address of Makers.	Tons of Water Raised per Minute.	British Gallons Raised per Minute.
Amsterdam Canal..........	Easton & Anderson, London, Eng........................	700	188,300
Witham, England.	Easton & Andersen, London, Eng.	400	107,600
Hauvill, Denmark..........	J. & H. Gwynne, London, Eng..........................	230	61,870
Grootslag, Polder, Holland·	J. & H. Gwynne, London, Eng......................	240	64,560
Bijlmer Meer, Holland.....	J. & H. Gwynne, London, Eng....	150	40,350
Amsterdam, Temporary....	J. & H. Gwynne, London, Eng.........................	120	32,280
Whittlesea, England..... .	Easton & Anderson, London, Eng......	88	23,672
Portsmouth, England	Easton & Anderson, London, Eng................	130	34,970
Glasgow, Scotland.........	Easton & Anderson, London, Eng.........	175	47,075
Cronstadt, Russia..........	Easton & Anderson, London, Eng.......................	300	80,700
Sajfoji, Hungary...........	J. & H. Gwynne, London, Eng..........................	100	26,900
Loosdrecht, Holland	J. & H. Gwynne, London, Eng.....	140	37,660
Legmeer Plassem, Holland.	J. & H. Gwynne, London, Eng...................... .	150	40,350
Ferrara, Italy.............	J. & H. Gwynne, London, Eng...............	2,100	564,900

The list includes only the larger plants, perhaps not one-half the whole number. Gwynne & Co., whose pumps are not mentioned in the list, have supplied previous to 1879 more than 30 plants for docks.

For a few years past there have been fewer large pumps erected than during a corresponding number of years previous, but the manufacture and application of the smaller sizes of pumps has been all the time increasing.

One extensive use recently developed has been for circulating water in surface condensers. There is scarcely a large steam-vessel without such pumps.

Some recent examples of large pumps in England that may be mentioned are the Sandon Docks at Liverpool. The pumps, and all the machinery connected with them, except boilers, were constructed by Messrs. J. & H. Gwynne, of Hammersmith, London. There are four pumps, each with discharge pipes of 36 in. diameter. The wheels or fans are 60 in. diameter, and run at 160 revolutions per minute. The quantity discharged in an experiment made in March last was 28,445 cub. ft., or 164,115 galls. per minute. The engines, four in number, have cylinders 30 in. diameter and 24 in. stroke. The pump wheels are keyed directly on the engine shafts. This plant, all things considered, is perhaps the most perfect of any one of its class that can be referred to at this time.

At Wall's End Docks, Newcastle, England, is a plant constructed during 1885 by Messrs. Tangye Bros., Limited, Birmingham. There are two pumps, with pipes 36 in. diameter, and rated for 50,000 galls. per minute. There has been no published test, however, and the amount of duty will, no doubt, much exceed what is named above. The pumps have single inlets, and are driven by directly geared vertical engines 20 in. diameter and 18 in. stroke. The disks or runners are 66 in. diameter, and are balanced one against the other by a continuous shaft passing through both pumps.

Another plant at Alexandria Docks, Hull, England, consists of four pumps to raise 80,000 galls. per minute, driven by two engines of 400 H.P., the cylinders being 30 in. diameter and 24 in. stroke.

The pumps are of the J. S. Gwynne type, the casing parted on the line of the pump spindle; strong, massive and with some change as to form from the practise of the firm some years ago.

One feature that commends itself is tapering the suction pipes. The lift is 24 ft. at the extreme. The up-flow becomes tardy at this height, and requires area to compensate for loss of movement. The plant has been much increased since 1886.

The centrifugal water-raising machinery constructed in England during 20 years past may be estimated at equal to raising 20,000 tons a minute. The lift in graving docks is from 25 to 30 ft. At Cronstadt it is 39 ft., and at Malta 39½ ft. The average, including draining plants, is perhaps 15 ft., and allowing 1 H P. for each ton per foot per minute it will aggregate 300,000 H.P., and of value at least $30,000,000.

Since the foregoing was written, in 1886, there has been noted progress in larger centrifugal pumps in this country. A number of dock plants to raise from 30,000 to 40,000 galls. per minute have been made in the East by the Southwark Foundry, at Philadelphia, and a number of pumps of equal size have been made and erected in California for draining purposes.

In future we may expect works as extensive as have been erected in Europe, perhaps larger, because the areas to be drained, or that may be drained, when land is dear enough to permit it, far exceed the requirements in Europe. The largest pumps will, no doubt, be those for circulating water in some of the cities around the North American Lakes. Some proposed for Cleveland, O., some years ago, required pipes of 60 in. bore. At New Orleans there is need of a number of such pumps for flushing and carrying off the sewage to Lake Pontchartrain. This work is now performed by lift wheels, at a fair economy in power, but with great waste for maintenance and attendance.

CENTRIFUGAL PUMPS AND HIGH HEADS.

At this time the problem of most interest in centrifugal pumping is in respect to high heads, especially on the Pacific Coast, where there is no choice between centrifugal and piston pumps in raising water from bored wells. The sand and gravel that come up with the water continually, prevents the use of piston pumps of any kind, and centrifugal pumps must be employed.

The heads operated against, down to three years ago, did not exceed 100 ft., but since that time they have increased, as will be seen from examples in the appendix, to 160 ft. without developing any circumstance that points to a limitation, and the makers of such pumps have no fear of working with fair economy against heads of 200 ft. or more.

There is no subject which at this time more strongly appeals to what may be called public facilities for confirmation by practical tests. No maker of centrifugal pumps is likely to, or can afford to, conduct such experiments, except for his own information and advantage. Computations, as we have been obliged to assume, do not fit the facts of operating, especially in respect to high heads, and there is, besides, the problem of transforming the discharge velocity from the impellers so as to utilize in the fullest manner the energy of revolution, it may be called.

The latter is but briefly treated here, because the behavior of the water cannot be observed or predicated with certainty, and nothing but experiments will determine the best form for chambers and water ducts beyond the impellers.

APPENDIX.

The following appendix, consisting of communications from engineers and makers of centrifugal pumping machinery on the Pacific Coast, it is believed will be a valuable addition to the matter that has preceded.

Professor Hesse was concerned in some experiments carried out in San Francisco in 1865 to determine whether the process called "disintegration" could be successfully applied to the reduction of gold and silver ores.

Disintegrating machines are driven at a velocity of about 1,800 revolutions per minute, and to insure a uniform effect in the crushing cylinder, the shaft was set vertical. As a test for resistance to rupture, the whole was set in a pit, with the plane of revolution below the surface of the ground, and in this condition rotated at a speed of 3,000 revolutions per minute. The weight carried on the step was about 800 lbs. The step soon "froze," as it is called, welded itself solid in the matrix, so that some new method was required. It was at that time, 1865, that Professor Hesse prepared plans for a hydraulic step by which the weight on these spindles was to be supported by pressure due to centrifugal force acting on one side of a plate or disk.

In 1887 he introduced the subject before the engineering classes in the University of California, and instituted a number of experiments to determine pressures, resistance and fric-

tion of disks with and without vanes revolving in water at high velocity.

These experiments form the subject of Bulletin No. 2, referred to in his communication below. Copies of it can be had at this time by applying to Professor F. G. Hesse, at the University of California, Berkeley.

COMMUNICATION FROM PROFESSOR F. G. HESSE, UNIVERSITY OF CALIFORNIA, BERKELEY.

"The work lost, or the mechanical equivalent of the heat developed by the rotation of a body in water bounded externally by fixed rigid walls, is a function of the geometrical figures of the rotating and stationary bodies, and of the velocity of rotation. In our problem, a disk, plain or armed with ribs, rotates about its geometrical axis within a body of water, bounded by a surface of revolution of the same axis.

"Let us consider a plain rotating disk, etc. Friction between the face of the disk and the water (outer friction) induces rotation of the adjoining layer, which in turn is transmitted by the actual action of the molecules (inner friction) at a decreasing rate, until the rotary velocity of the film in immediate contact with the bottom of the vessel is zero.

"The rotary velocities induce again radial currents from the axis in the neighborhood of the rotating disk, and toward the same near the bottom of the vessel, and, in conformity with the law of continuity, component velocities normal to the rotating disk complete the circulation. For the sake of brevity I have omitted the influence of the outer boundary. The moment of resistance of the rotary disk must be equal to that of the vessel, a fact upon which the tests, as described in Bulletin No. 2, were based.

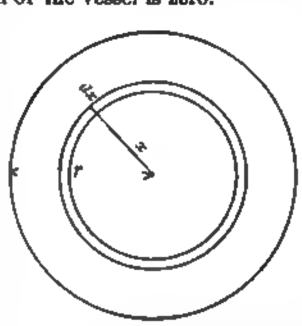


Fig. 17.

"Practically the outer friction is by far the most important factor in the heat development, and we are justified in constructing the formula upon the following experimental facts, using the annexed notation :

A represents the water area.
v, velocity of rotation.
λ, a constant.
R, the resistance.
γ, the density of the fluid (water).
w, angular velocity of the disk.
n, number of revolutions per minute.

$$R = C \gamma A v^2$$

"Applying the above to the rotation of a plain disk (fig. 17) we have differential of R, that is, $d R = \lambda \gamma 2 \pi x \, dx \, w^2 x^2$, and differential of moment of resistance, that is, $d M = \lambda \gamma 2 \pi w^2 x^4 \, dx$, hence

$$M = \frac{\lambda \gamma 2 \pi w^2 x^5}{5}$$

$$\text{and } L \text{ (work)} = \frac{\lambda \gamma 2 \pi w^3 x^5}{5} \text{ or}$$

$$L = \frac{\lambda \gamma 2^4 \pi^4 x^5}{5 \times 60^3} n^3 = \frac{\lambda}{10} d^5 n^3,$$

or for compound action $L = \frac{\lambda}{10} d^5 n^3 m$ (the same result as given in Bulletin). The constant λ is a function of n and d. (See Bulletin, page 21.)

"I call attention to the fact that the value of λ, hence the work in the case of the rotating disk being armed with ribs, is nearly 2.8 that of the plain disk. This is due to the rotation of a large body of water at a velocity equal to that of the disk, and also to the resisting action of the outer or circumferential surface of the vessel."

Fig. 18 shows part of the apparatus employed by Professor Hesse in his experiments for thrust. The vanes A are attached to the revolving disk, and the vanes B B are fixed to prevent rotation of the water beneath the disk. The spindle D is free from all frictional resistance vertically, and presses on the abutment C connected with suitable weighing apparatus to determine the vertical thrust.

The apparatus employed by Professor Hesse was of a very complete character, accurately and carefully made, and the observations were recorded by equally exact means, in some cases by electrical devices, as explained in the text and drawings of the Bulletin No. 2 before referred to.

CAPACITY OF CENTRIFUGAL PUMPS.

An extract from a paper read before the Technical Society of the Pacific Coast, June 2, 1893, entitled "Some Problems in Pumping Fluids," by J. Richards.

"This comparison has been made to show the economical difference between continuous and intermittent action, which is the chief distinction between these two methods of pumping. There is no reason why 1,200 galls. per minute could not pass through the piston pump the same as it does through the centrifugal one, if there were not limitations of some kinds that take away nine-tenths of the capacity of piston pumps. The relative capacity of piston and centrifugal pumps is shown in figs. 19 and 20, representing the waterways, and approximately the volume in the suction pipes, pumps and discharge pipes.

"As at first remarked, this difference between the two methods of pumping seems to rest in 'constant flow' in one case, and 'intermittent flow' in the other case, which is mentioned at this time in advance of its proper place to enable a better understanding of some further comparisons to be made. By examining lists of centrifugal and piston pumps it will be seen that the suction and discharge pipes of the former are made of a larger diameter than the pump's bore. In this State the smaller class of centrifugal pumps are usually made with discharge pipes having four times the capacity of the pump nozzles, the suction pipes the same. To quote an example, or several examples now in mind, the diameter of the pump nozzles are 5 in.; diameter of the up-take pipes, 10 in. Suction pipes, of which there are from two to four, 6 in.; suction inlet to pumps, 8 in. With larger pumps these proportions do not hold, but the pipes are in all cases made larger than the pumps to which they connect.

"Turning to piston pumps we find the pipes with capacity only a third or fourth as much as that of the pump's bore, or, comparing with centrifugal pumps, about one-seventh as large, and are in proportion to the flow in the two cases. Here, then, is an anomaly, two machines for impelling water under like conditions for average heads, one costing twice as

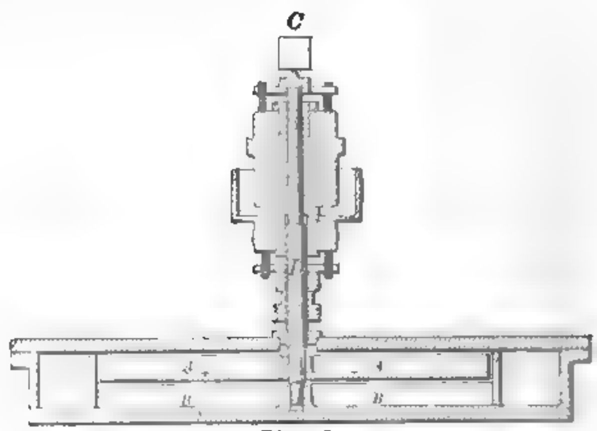


Fig 18.

much as the other and performing one-tenth of the duty. Behind this must lie some potent feature of method or operation which we find primarily in the difference of velocity at which the fluid passes through the pumps, and from that can lay down a first postulate as follows :

"*The dimensions, weight and first cost of pumping machinery are inversely as the velocity with which the water passes through it.*

"The velocity which we have seen is as ten to one, or thereabout, can be illustrated in the two cases by diagrams, as in figs. 19 and 20, where the ordinates represent the diameter or capacity of the water ducts in the suction pipes, pumps, and discharge pipes as taken from actual practise here in California.

"This branch of the subject can now be left to trace out the causes of this difference, and why, as in the case of piston pumps, water is moved by 'jerks,' to so call it. This limitation is found in the variation and cessation of velocity of the water in the pumps and usually in the suction pipes, and when considered as a dynamical problem the wonder is that a flow of even 1.5 ft. per second can be attained in this manner of pumping.

"The ordinates in fig. 21, and the figures set opposite, represent one stroke of a crank-moved pump piston, showing the

changes of velocity, and from this we can derive a second postulate as follows:

"*The limitation of capacity in reciprocating piston pumps amounting to from eight to nine-tenths of their normal capacity is due to intermittent and irregular flow.*"

FROM THE SAN FRANCISCO TOOL COMPANY.

The following matter, with the drawings, has been furnished by the San Francisco Tool Company, and will constitute a problem of much interest in connection with our present subject.

The result seems phenomenal, considering that the water is twice set in revolution, and as often passes through the sinuous ducts of the pumps, but those most familiar with centrifugal pumps and the anomalous results that sometimes appear, will be least likely to criticise the "findings," in the present case.

Some years ago, the writer was connected with the first experiment made in California to raise water against a head exceeding 75 ft., with a centrifugal pump. It was compounded, but so constructed that none of the tangential energy was utilized. When the two were operating in series they gave precisely double the pressure the first one did, and the power consumed for raising a given quantity of water determined by comparison in the same manner—that is, by fuel consumption, was no more than with barrel pumps that had been in use at the same place.

The present case, and some others to be noticed in this appendix, will bear out no doubt the claim heretofore made, that the art of centrifugal pumping, so to call it, has on the Pacific Coast undergone a development more extensive than in any other part of the world. The arrangement and design of the pumps in this case are well shown in the drawing, and do not call for comment.

Test Made for the San Francisco Tool Company on the Compound Vertical Centrifugal Pump shown in Fig. 22. *Campbell Water Company's Works, Campbell, Santa Clara Co., Cal., July* 18, 1894.

PARTICULARS OF TEST.

No. of Test.	Water.			Heads.		Revolutions per Minute of Pump.	Net Indicated H.P. of Engine.	Theoretical H.P. of Lift.	Per Cent. Efficiency of Pump, including Pump Friction.
	Width of Weir in Inches.	Depth of Water on Weir in Inches.	Gallons.	Total Friction Head, including two check valves.	Total Head.				
1	11¾	6⅛	529	3.00	111.5	546	20.03	14.90	74.40
2	13¼	6⅛	596	3.25	115.0	560	24.32	17.31	71.25
3	13½	6⅛	607	3.25	116.2	565	25.58	17.79	69.50
4	13¼	6⅛	619	3.30	117.2	568	26.58	18.60	68.00
5	10 5/16	6⅛	465	2.80	108.0	533	22.65	12.69	56.00
6	12⅛	6⅛	545	3.00	111.5	548	22.78	15.35	67.40
7	11⅜	6⅛	529	3.00	111.5	546	25.25	14.90	59.00
8	11¼	6⅛	506	2.88	110.2	540	24.00	14.05	58.50
9	11⅞	6⅛	534	3.00	111.5	546	22.67	15.11	66.60
10	12½	6⅛	562	3.12	113.7	552	26.97	16.04	59.50
11	12	6⅛	540	3.00	112.5	550	24.71	15.85	62.10
Total	134 1/16	.....	6,032	33.60	1238.8	6054	265.54	172.09	712.25
Av'rage	12.18	6⅛	548	3.05	112.6	550 36	24.14	15.64	64.78

REPORT OF TEST.

Average total head .... 112.6 ft.
" discharge head .... 87.5 "
" suction head .... 22.07 ft.
" capacity per minute .... 548 galls.
" number of revolutions per minute .... 550.36 R.P.M.
" friction head .... 3.05 ft.
Diameter of discharge pipe .... 7.62 in.
" " suction pipes .... 2–7.00 "
Average indicated H.P. of engine pump .... 32.04 H.P.
" " " " " friction .... 7.90 "
" power applied to pump belt .... 24.14 "
" water delivered by pump .... 15.64 "
" efficiency of pump .... 64¾ per cent.

NOTES.

In the above tests the pump was in a pit 83 ft. below the surface of the ground.

Power was transmitted to the pump by means of shafting, of which there is about 90 ft. of 2¼ in., and 5 couplings, all connected and standing vertically, and held in place by means of about twelve 2¼ in. bearings. The upper end of the shaft runs through a bow frame in the usual manner, and has a 22 in. × 18 in. pulley, and is connected to an Atlas engine (11 in. × 16 in.) by means of a 14 in. rubber belt. Pulley on engine is 66 in. × 14 in.

Distance between centers of engine and pump pulley is 21 ft.

A wooden idle pulley 20 in. × 18 in. running on a 2¼ in. shaft between two 2¼ in. bearings keeps the belt taut.

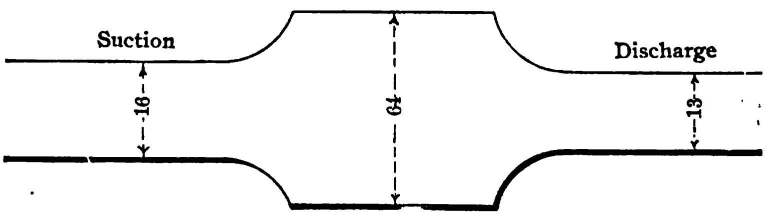


Fig. 19.

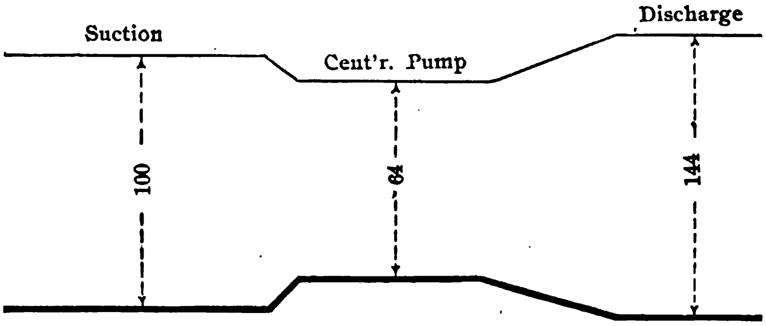


Fig. 20.

In the above percentages of efficiency, no deductions have been made for driving the 2,000 lbs. of shafting, couplings, pulley, etc., nor the friction of couplings and pulleys fanning the air, nor friction of the shaft in its many bearings and the idle pulley, neither was the loss in transmission (by quarter turn belt) between engine and pump deducted.

The only deduction made was the friction of engine running light, with driving belt off.

Signed, G. W. PRICE.
R. L. FRIES.

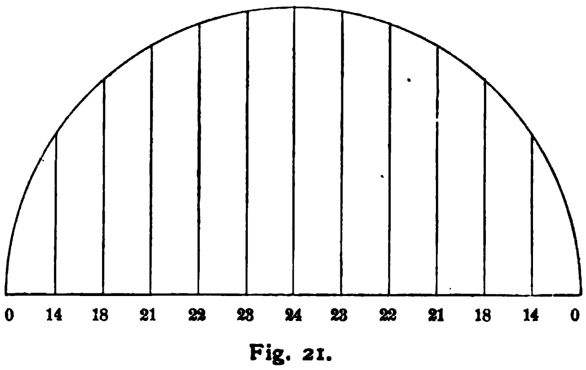


Fig. 21.

REMARKS.

"This pump replaced a pair of 16-in. bore × 48 in. stroke Cornish pumps, which were built and put in last March and April by a well-known California company. Owing to the large amount of sand and gravel carried by the water of these wells the Cornish pumps proved their unadaptability from the moment they were started up. It was a matter of a few hours only before the pump barrels were filled with sand and gravel, even on top of the pump pistons gravel and dirt would pile up to a depth of from 2 to 5 ft., the depth being governed by the length of time the pumps would run before breaking down.

"The centrifugal pump was driven by the same steam plant that was used to furnish power for the Cornish pumps. The difference in power required to operate the different pumps was noticeable in every detail.

"In the tests above named the efficiency of the pumps was impaired by an unforeseen length of the suction head, due to

a want of supply in the wells. This head sometimes reached 26 ft., giving a flow of only 2 to 2.5 ft. per second, estimated as affecting the working result over the whole test of 3 to 6 per cent.

The suction pipes are about 30 ft. long, but are perforated from the bottom up to within 26¼ ft. of the pump.

"In the fourth test the level of the water in the suction pipes was kept close to the limit set by the perforations in the pipes. Just before the fifth test the water went below the perforations, and the pump drew in air and partly lost its priming. This threw the impellers slightly out of balance.

"In the fifth test there was a very small quantity of water owing to air being in the pipes and pump, and the efficiency was low from the fact that the impellers vibrated vertically, which caused more or less friction between the thrust collars and their bearings, and to the small quantity of water discharged.

"By the time that the sixth test was made the pump was fairly well filled again, although there was a very perceptible variation in the quantity and efficiency during the remainder of the test. Still this is a condition which is liable to exist at any time and under different circumstances, so they have been included in the log of tests. From the tests as made the efficiency obtained can be relied upon as representing average results when working under favorable conditions.

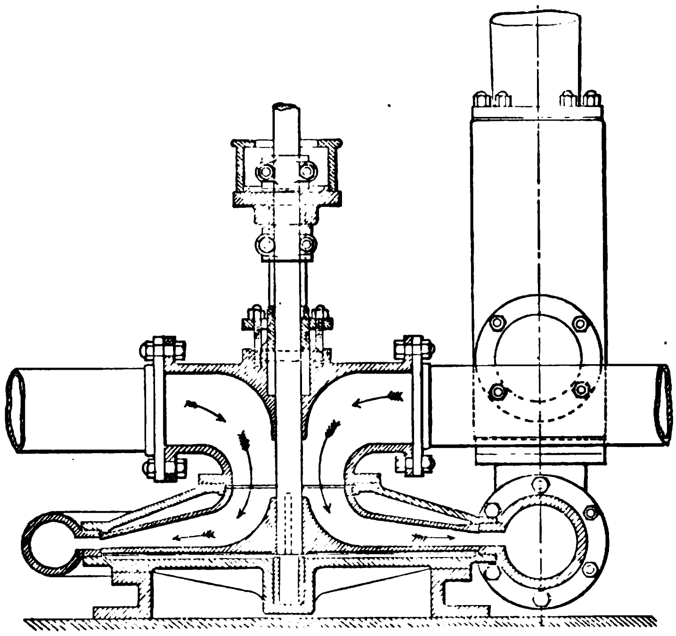


Fig. 23.

PUMP AT THE SAN JOSÉ WATER WORKS.

"The water delivered by the pumps contained a large quantity of sand, which if introduced through the pipe *B* into the cylinder *A* would in time impair the efficiency of the balancing piston (detail shown in fig. 11, page 416). To avoid this, and also to balance the shafting before starting the pump, the pipe *B* was continued on up to the surface of the ground, and then connected to a small reservoir in the bottom of the discharge flume, a strainer being placed over the aperture between the reservoir and the flume. In this manner clean water was obtained for the balancing piston. The stem on the regulating valve, shown on pipe *B*, was continued up to the top of the pit for convenient regulation of the pressure in the balancing cylinder *A*.

"The principal features of design and construction of this pump are as follows:

"1. The proportion of the scroll chamber of the pump is such as to give a velocity of flow which this company have found by their experiments to be the most efficient.

"2. The diameter and curve of the impeller blades are so proportioned that the water leaving the impeller has the same tangential velocity when it reaches the scroll chamber of the pump as the discharge water has when passing through said chamber. This avoids all loss of power from shock, impact and eddies, which always takes place in pumps not properly proportioned. To keep these velocities constant it is necessary with the higher heads to use two or more impellers.

"3. The weight of the revolving parts must be maintained at all times in equilibrium. The company employ the method of balancing shown in figs. 9, 10 and 11, described on page 416 (*ante*) to sustain pump shafting, couplings, pulley and impellers. Any variation in the suction or discharge heads will not unbalance the shafting.

"4. The impellers in the pump being inverted they are in equilibrium in so far as end thrust, leaving only the gravity of the rotary parts to be sustained by the balancing piston at *A*."

Since the foregoing matter was in type the engineer of the Campbell Water Company has apprised the makers of the pump illustrated and described in the preceding test and notes, that a large tank was erected at an elevation of 44 ft. above the old flume, and the pump discharge pipe connected to this tank of 20,000 galls. capacity, which is filled in about 30 minutes, or at the rate of 666 galls. per minute. The total head, including friction, the engineer estimates at 160 ft., and there is little doubt that it may be further increased if required.

The most singular part is that there has been no augmentation, or change, in the driving power, and the 44 ft. of added head has certainly not produced resistance in accordance with the usually assumed law in such cases, or as the cube of the head or speed. The present case, and others of the kind, disprove by actual experiment any such limitation of head or resistances in centrifugal pumping.

FROM MESSRS. W. T. GARRATT & CO., SAN FRANCISCO.

The company above named supply the following interesting facts in respect to the pump shown in the drawing on this page. The general design, as seen, is simple, and carried out carefully in respect to proportions, curves and section of the waterways, and compares to designs made by the author for Messrs. W. T. Garratt & Co. in 1887, since then extensively applied to raising water from deep wells on the Pacific Coast.

The pump from which the drawing is taken is one of 5 in. bore that has been at work for more than two years past, raising 900 galls. per minute, or at the rate of 12,000,000 galls. in 24 hours, against a head of 123 ft., for the city service at San José, Cal.

This is the highest pressure for a single pump operating in constant service that can be referred to at this time. Pumps less adapted to high pressure have been operated against a head of 130 ft. for a time, but not, as in this case, for constant daily service.

The following notes are sent by the makers:

"The drawing is to a scale of $\frac{1}{16}$ — ⅜ in. = 1 ft. The pump was erected about July, 1892. The discharge nozzle is 5 in. diameter, and the impeller 30 in. diameter. The suction pipes (two) are 6 in. diameter. The up-take pipe, above the air vessel, is 10 in. diameter. The engine employed is of 50 H.P., rated, and speed of the pump about 700 revolutions per minute.

"The driving shaft is about 90 ft., and with attached weights, such as pulleys, couplings and pump parts, amounting to more than a ton, is perfectly balanced by water thrust beneath the impeller, the shallow vanes there being trimmed at the works to balance at a low head, the shaft and its fittings compensating for added head up to 123 ft.

"The foot-pounds of work, 922,500, make about 28 H.P., and, while no accurate tests have been made, we believe the efficiency to be as high as 60 per cent., and quite as much as can be attained with a piston pump, such as is commonly employed under the conditions. The water is drawn from gravel strata through tube-wells, and contains a great deal of sand and grit that would soon destroy pumps having sliding surfaces.

"In experimenting with the pump there was developed some anomalous conditions of working, not explainable by our previous experience. At an increase of speed from 700 to 800 revolutions or more, the work fell off to some extent, and there is apparently a determinate volume or flow at which the greatest efficiency is attained.* The water is balanced according to the usual formula $V = \sqrt{2gH}$, or at 675 revolutions, the impeller being 30 in. diameter. This leaves 75 revolutions to overcome the resistances to flow."

UTILIZING TANGENTIAL ENERGY.

There is an account in *Le Génie Civil*, Vol. XXIV, page

* The pump having a cut-off or throat piece, and requiring a definite speed in respect to the head, there is nothing strange in the result above noted.—J. R.

392, of a centrifugal pump designed by M. Schabaver, in which the discharge from the impeller enters an annular chamber consisting of a narrow slit around the impeller, widening out gradually to the discharge chamber. The comparison with common practice is in gradually reducing the velocity of the discharge water from the impeller, so as to utilize as far as possible the radial energy, compared with discharging directly into the scroll or discharge chamber, gaining thereby inductive effect only.

The utilization of the rotative energy in this manner is not a new subject, in so far as its dynamical treatment. Professor James Thomson presented before the Institution of Civil Engineers, in England, nearly 20 years ago, a paper in which the utilization of tangential energy in centrifugal pumps was treated from a mathematical point of view, dealing with the forces involved in an abstract way, and proposing a "whirlpool" chamber beyond the impeller.

In 1884–85 Mr. Byron Jackson, of San Francisco, embodied in a series of pumps what he called whirlpool action, the object of which was to absorb and utilize the energy due to the velocity with which the water leaves the impeller. Mr. Jackson's practice corresponds to that shown or described in the

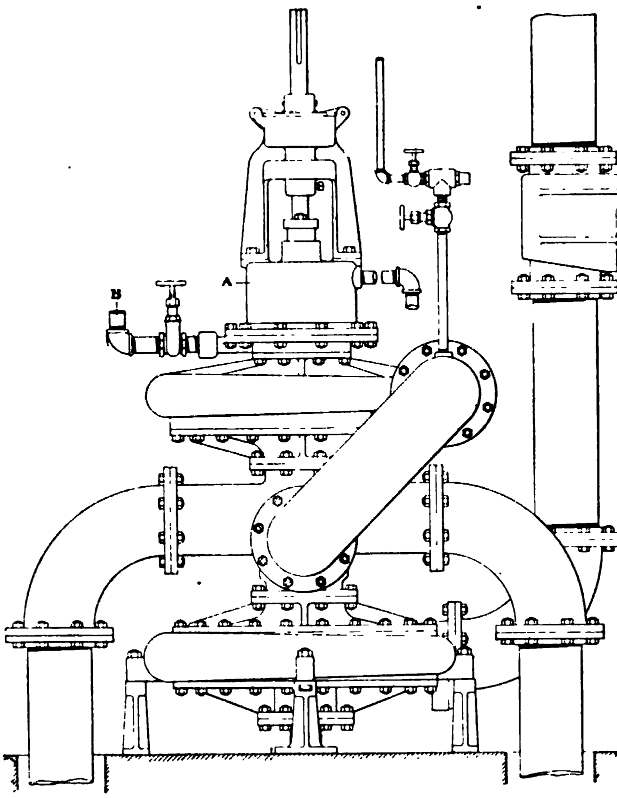


Fig. 22.

COMPOUND VERTICAL CENTRIFUGAL PUMP.

Schabaver pumps, but without the diverging sides or expanding chamber between the impeller and the discharge way, he relying on the increasing section due to increasing diameter, otherwise the action of the pumps is the same.

But even the diverging sides or expanding chamber between the impeller and discharge-way is not new. In 1892, Mr. G. W. Price, also of San Francisco, prepared drawings, which we have examined, for pumps identical with the alleged invention of M. Schabaver, and in which the section of the water way is made to correspond with the diminishing velocities and increase of volume from the impellers outward, so this feature of construction comes back to the Pacific Coast, and sustains our claim of an advanced practise there.

The account of the Schabaver pump, by M. Gérard Lavergne, is as follows:

"The limit for the profitable employment of centrifugal pumps has hitherto been held to be at lifts of 40 to 50 ft., while their best efficiency is found at lifts considerably lower. The combination of two or more centrifugal pumps in series, one delivering into the suction pipe of another, enables them to be used for high lifts without loss of efficiency, but at the cost of some complication and a large initial outlay.* The present article describes methods of construction which have been devised by M. Schabaver to adapt the centrifugal system to high lifts. The object of the construction is to enable the high velocity with which the water must leave the blades of the pump to transform itself into low velocity with high pressure, and at the same time to avoid the shocks and eddies by which energy is dissipated at high lifts in the ordinary centrifugal pumps. To effect this purpose the discharge through the wheel casing is taken through a narrow orifice extending round the whole circumference of the casing. This orifice gradually widens outward, so that the water arrives without shock in a spiral collector surrounding the pump and leading into the discharge pipe. The width of the orifice is made such as to give the required flow at the velocity due to the head against the pump, with a coefficient of contraction (about 0.6) allowed for. A series of experiments were made with a pump of this type of 16 in. diameter across the blades, with 4 in. suction and discharge. It was actuated by a 25-H.P. engine, whose efficiency, measured by comparing the work on a brake with the indicator diagram, was 80 per cent. The efficiency of the transmission was also obtained, and thus by taking indicator diagrams the work transmitted to the pump shaft could be calculated. Diagrams are given of the efficiency of the pump in terms of the lift for deliveries varying from 1 to 4¼ galls. per second, in which the lift ranges from 0 to 164 ft. The maximum efficiency is 58 per cent., and was found only with the greatest flow—viz., about 4¼ galls. per second. For any flow the maximum efficiency occurred at about 50 to 60 ft. lift and increased continually with the flow. The variations of efficiency from one lift to another were also less with the larger flow. The same results are expressed in another set of curves which give the efficiency as a function of the flow. In another diagram the height to which the water was raised is expressed as a function of the speed of the pump. A similar curve being drawn to express the theoretical lift as given by the equation $v^2 = 2\,g\,h$, where v is the resultant of the radial and tangential velocities at the various speeds, it is seen that the pump fulfills its purpose very perfectly in reducing the velocity of the water without loss of head.

"In another form of pump directed to the same purpose, the blades are made hollow and large, occupying half the volume of the casing and covering half its circumference—somewhat of the form of a hatchet-blade. The blades are set radially, since it is found that the loss by shock at the entrance of the water is insignificant. This arrangement of blades, together with a gradual enlargement of the casing in the radial sense, gives the water, after issuing from between the blades, plenty of space in which to lose its velocity without shock before entering the discharge-pipe. This pump, delivering 5¼ galls. per second to 65.6 ft. of height, gave an efficiency of 65 per cent., and delivering 6¼ galls. to 32.8 ft. of height gave an efficiency of 68 per cent. With further experience still better results may be expected."

There is a provoking omission of the efficiency in working at different heads, from 0 to 164 ft. There is also something inexplainable in the statement that "for any flow the maximum efficiency occurred at 50 to 60 ft. lift, and increased continually with the flow." Unless the translator is wrong here, the experimenter was, because such a result is hardly supposable.

The results described in the last paragraph are not surprising. There are several reasons why vanes of the form described should give a good result. The fact of their being set radially shows that the designer attached but little importance to the curve or shape of the vanes. —*Industry.*

ENGINE CYLINDER CLEARANCES AND INITIAL CONDENSATION.†

By Michael Longridge, M.A., M.I.C.E.

The examination of such cylinder drawings as have been submitted to the writer's consideration during recent years has led him to believe that he may, without presumption, and perhaps with advantage to steam users, draw attention to a point which, though it materially affects economy of working, seems to be frequently overlooked in cylinder designs. That point is *the amount of clearance surface.* All engineers,

* The amount of "initial outlay" is not great, but is inconsiderable, as can be seen by comparing with fig. 22, and in any case is not more than half as much as for piston pumps.—J. R.

† From the Annual Report of the Engine, Boiler and Employers' Liability Insurance Company, for 1898.

and many who use engines, are aware that the weight of steam passing through the cylinder, as measured from the indicator diagram, is always less, and generally considerably less, than the weight of water evaporated in the boiler. The difference they ascribe, quite correctly, to cylinder condensation, and they see that but for this condensation the quantity of steam used and the weight of coal burnt for a certain H.P. would be very much less than they actually are. Anything, therefore, that tends to increase or diminish initial condensation is worth consideration. Now, it is generally admitted that cylinder condensation is produced by cylinder metal; that it is most active during the first part of the admission before the piston has begun to move, and that the quantity of water in the cylinder ceases to increase either when or soon after the steam has been cut off; in other words, that the extent of the metallic surface exposed to the steam during the period of admission determines, to a very large extent, the amount of the cylinder condensation and the economy of the engine.

This is the point which seems to the writer to be sometimes lost sight of. Let us take one or two examples: Consider figs. 1 and 2, representing the clearance at the back end of the high-pressure cylinder of a compound tandem condensing engine. The diameters of the cylinders were 12 in. and 22 in.; the stroke of the pistons 2 ft. 6 in.; the speed 80 revolutions per minute; the cylinders were completely jacketed, and the high-pressure had Corliss valves; the boiler pressure was 80 lbs., and the number of expansions varied from 12.9 to 19.2. Surely such an engine should have been economical. Yet the rate of consumption was found on trial to vary from 20 lbs. per I.H.P. per hour with steam in the jackets, to 21 lbs. with the jacket supplies shut off.

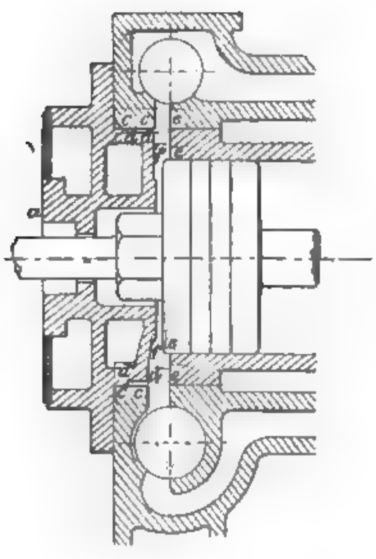


FIG. 1.

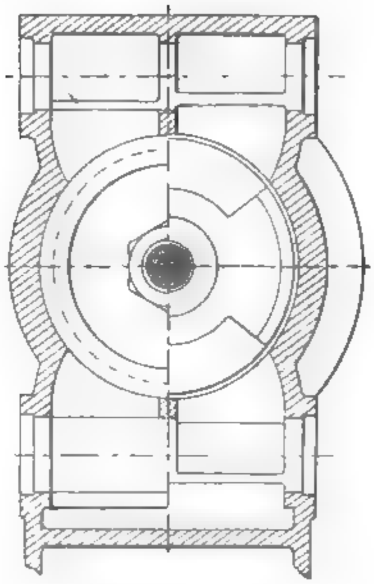


FIG. 2.

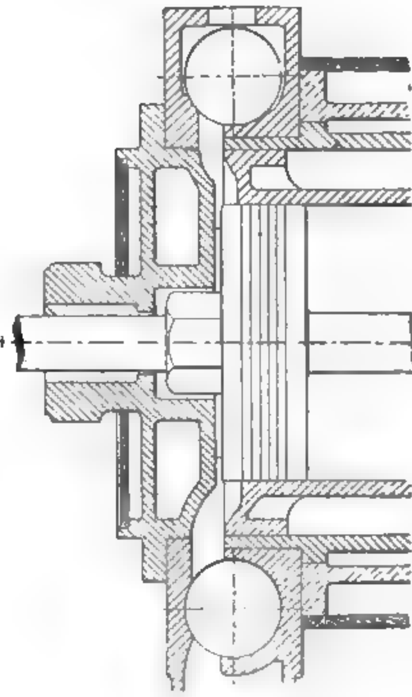


FIG. 3.

The indicator diagrams of which fig. 3 is a specimen suggest the cause—the slow rise of the compression curve, the appearance of late admission, although the valves had nearly 1/16 in. lead, and the full expansion curve all point to excessive initial condensation and in fact from 51 per cent., or roughly speaking one half, of the steam entering the cylinder was condensed during the period of admission. Why was the condensation so excessive? Rather ask, Why was the surface exposed to the entering steam so great?

The volume swept through by the piston up to the point of cut-off in the particular trial which gave the mean diagram (fig. 3) was 0.29 cub. ft. The surface required to contain this volume is that of two circles, each 12 in. diameter, and a belt of the circumference of the cylinder 4.4 in. long—altogether 2.72 sq. ft., or 9.4 sq. ft. per cubic foot contained. This is the irreducible minimum of surface, the ideal at which the designer of the cylinder should have aimed. The actual amount of surface is 7.9 sq. ft., or 27.3 sq. ft per cubic foot, of which the clearance surface or the surface exposed to the steam before the piston begins to move amounted to no less than 6.75 sq. ft., or 35.5 sq. ft. per cubic foot of clearance volume.

Let us see, now, how this extra surface was brought in.

First, we have a nut to secure the piston to the piston-rod, and a large recess in the cover to receive the nut. A cotter sunk in the piston would have presented less surface to the steam; but if a nut was preferred, it need not have been so deep, nor need the clearance between it and the bottom of the recess have been about three times as much as between the piston and the cylinder cover.

Second, there is no collar bush in the cover to prevent the steam getting into the stuffing-box as far as the metallic packing, which is bolted to the flange *a b*; consequently the whole of the surface in the neck and stuffing-box are condensing and evaporating surfaces. In many cases this surface is much greater than in the present instance. It is said that one of the advantages of metallic packing is that it leaves the rods free, and therefore it is not desirable to have any collar bush. The writer would rather say that one of the advantages of metallic packing is that it will adjust itself to the rod and keep the gland steam tight if the piston and collar bush wear down, and the rod does not run exactly coincidently with the axis of the cylinder.

Third, there is a space between the cover and the cylinder *c d*. This is bounded by two belts of surface *c c*, *d d*, in this case each only 1¼ in. wide, but in some instances as much as 9 in. It is difficult to say how this surface is to be suppressed, for if the cover were made to fit the cylinder it would be impossible to get it off. Is it possible to make the cover conical and an exact fit into a conical spigot in the cylinder, so that when the asbestos thread or lead wire or other material used for jointing is put between the flanges, the male and female cones shall be just clear of each other, the space being so small that water would be held in it by capillary attraction? As to the maximum thickness of the annular space which will hold water under such circumstance, Mr. Bryan Donkin has been kind enough to make some experiments for the writer, which have shown that when the space is 1/16 in. water is not retained, but the surfaces *c c*, *d d* are both active as condensers and evaporators. When, however, the space is reduced to 1/32 in. water is held to a certain extent. These experiments were made with a "Revealer," so that the condensation and evaporation might be visible. In the case of the cylinder of a steam-engine it is probable that a space of 1/32 in. would be sufficient to ensure inactivity of the bounding surfaces, as oil would undoubtedly be deposited upon these surfaces, and would soon reduce the space between them sufficiently to ensure the retention of water between them, and thus prevent the entrance of steam and the consequent condensation

and re-evaporation due to their absorbing and giving out heat.

Fourth, there is the end surface *e e* of the liner, and the corresponding annulus *d f* of the cover, amounting to no less than

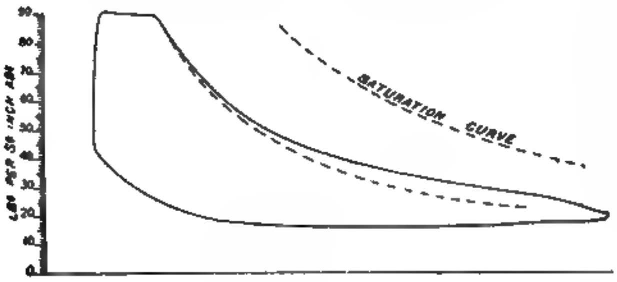


Fig 3.

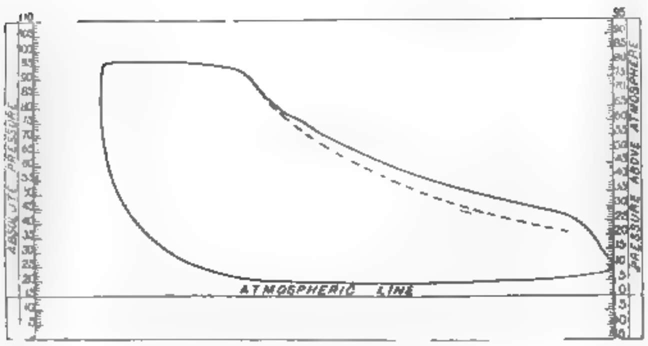


Fig. 4.

1.22 sq. ft., or 15½ per cent. of the total surface exposed to the steam up to the point of cut-off. This is the price paid in this instance, and not in this instance only, for a steam jacket to the barrel of a cylinder. If condensation be proportional, *ceteris paribus*, to surface, it means that by putting in the liner to form the jacket we have increased the cylinder condensation by 8 per cent., when working without steam in the jacket, beyond what it would have been had there been no liner and no jacket. The point is not without importance, because it is a common practise to assert, or at least to imply, that because a jacketed engine proves to be more economical with steam in the jackets than without, therefore the engine is more economical than it would have been had there been no jacket. It does not seem to occur to the exponents of such opinions that the engine might have done better without the jacket altogether than with the jacket and the steam supply shut off. The writer does not wish the foregoing remarks to be taken as implying that jackets are a useless complication. All he wishes to make clear is that a barrel jacket may be put in in such a way as to be a source of loss instead of gain.

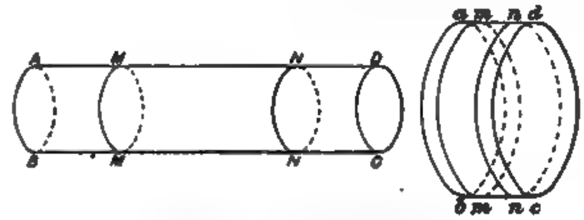
Fifth, there are the steam passages and the exhaust valve-boxes and valves. The surface of the steam passages is least in a cylinder with a slide-valve at each end, because there is only a single short passage at each end. And here it may be well to point out that the internal surfaces of this passage are not cooled by the escape of the exhaust through them any more than they would be if the exhaust escaped through special passages, for the temperature to which the metal is exposed is in either case that corresponding to the exhaust pressure. In the Corliss cylinder there are two passages at each end, unless the steam-valves be placed underneath and alongside the exhaust-valves, and the steam be admitted through the exhaust valve boxes. In small cylinders, however, little is gained by this device, though for large ones it affords a means of reducing the surface considerably. Also in the Corliss engine there is always the concave surface and two ends of the exhaust valve-box, as well as the corresponding surfaces of the exhaust-valve. How much of this can be rendered non-effective by making the valve fit the box it is difficult to say. The usual plan is to make the valve fill all that part of the box which is not required for the passage of the steam through it when the exhaust port is open, the object being to reduce the clearance space. But in the high-pressure cylinder of a compound engine clearance surface is probably of more consequence than clearance space, and if valves cannot be made to fit so closely to the surface of the box as to prevent steam getting between the two, it might be better to accept the whole internal surface of the box as an inevitable evil, and to reduce that of the valve by cutting it down to the smallest dimensions, regardless of the consequent increase of the clearance volume.

Let us take another case, fig. 5; the case of a cylinder reduced in diameter by means of a liner. This is a plan often adopted when steam pressures are raised, but it is not always as successful as expected, nor is it always safe, for the area of the cylinder end which is exposed to the increased pressure is not reduced. In the present case, the cylinder was originally 32 in. diameter by 3 ft. stroke, and the diameter of the liner is 28 in. The surface presented to the steam by the liner and by the corresponding annulus of the cylinder cover amounts, therefore, to 5.4 sq. ft. or to nearly twice the area of the piston. The clearance surface and volume are 18 3 sq. ft. and 1.18 cub. ft. Had the steam been cut off at 0.147 of the stroke, as in the former case, the surface exposed to the steam would have been 20.97 sq. ft., or 16.5 sq. ft. per cubic foot of volume swept through. When the diagram (fig. 4) was taken the admission continued nearly twice as long, or till 0.3 of the stroke, yet the effect of the large extent of surface in producing condensation becomes evident on comparing the expansion curve with the hyperbola. As a contrast, turn to fig. 6, representing the end of a cylinder 22 in. diameter by 3 ft. stroke. Here the clearance surface and volume are reduced almost as much as it is possible to reduce them, the first being 8.02 sq. ft., and the second 0.369 cub. ft. Assuming the steam to be cut off at 0.147 of the stroke, as before, the surface per cubic foot of volume swept through by the piston up to the end of admission would be only 6.9 sq. ft. The writer hoped to have been able to give a diagram from a cylinder of this design, but unfortunately the engine was not completed in time.

There is one other point in connection with cylinder surface which it may be well to touch upon, having regard to the large number of short-stroke inverted vertical engines which are now built for driving mills. This is the effect of the ratio between the cylinder diameter and the stroke.

To make the point clear without unnecessary complication, consider the two plain cylinders *A B C D*, *a b c d*, fig. 7, without ports or clearance spaces, *A B C D* having a piston area of 1 sq. ft. and a stroke of 4 ft., and *a b c d* a piston area of 4 sq. ft. and a stroke of 1 ft.; then both cylinders will have

Fig. 7.



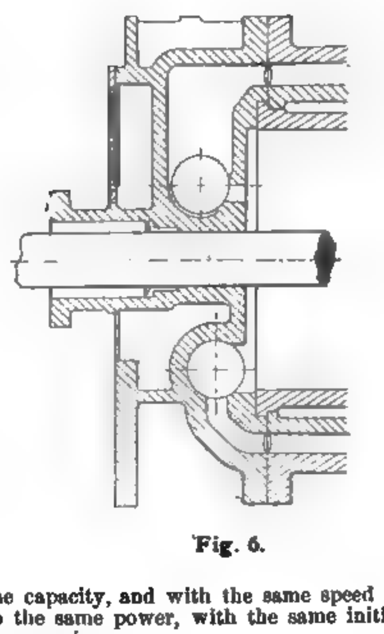


Fig. 6.

the same capacity, and with the same speed of rotation will develop the same power, with the same initial pressure and ratio of expansion.

First, suppose the cut-off to take place at *M* and *m* at one-

A JAPANESE CANTILEVER BRIDGE, BUILT IN THE PROVINCE OF ETCHIN IN 1668.

fourth of the stroke; then the volume of the steam admitted in each case will be 1 cub. ft., but the areas of the surfaces which enclose this 1 cub. ft. will differ considerably, the areas of the two ends and of the belts *A M*, *a m* of the barrels being 5.54 sq. ft. and 9.78 sq. ft. Therefore, if condensation be proportional to surface, the quantity of steam condensed in the short-stroke cylinder would, other things being equal, be 177 per cent. of that in the long.

If, however, the steam, instead of being cut off at one-fourth, were cut off at three-fourths of the stroke, the case would be different. Then the volume of the steam cut off *A N N B*, *a n n b* would be 3 cub. ft., and the enclosing surfaces 12.62 sq. ft., or 4.21 sq. ft. per cubic foot in the case of *A B C D*, and 13.33 sq. ft., or 4.44 sq. ft. per cubic foot in the case of *a b c d*. Therefore, other things being equal, the condensation in *a b c d* would be 106 per cent. of that in *A B C D*. Thus, even if both engines were run at the same number of revolutions per minute, the short cylinder will have but little more water at the point of cut-off than the long one when the cut-off takes place late in the stroke.

Generally, however, the two engines would not be run at the same number of revolutions per minute, but rather at the same piston speed, in which case the short-stroke engine would make four times as many revolutions as the long-stroke, and the periodic times during which heat is absorbed and given out would be in the inverse ratio of the revolutions.

Now, it has been assumed, in discussing initial condensation, that the amount of condensation is proportional to the square root of the periodic time. How far this assumption is based on fact remains to be ascertained, but supposing it to be true, then so far as it is affected by the number of revolutions, the condenser would be twice as great in the long-stroke engine as in the short. Thus, when running at the same piston speed, the short-stroke engine would make less water than the long.

There is no intention of asserting that these conclusions are beyond question. They will be modified somewhat when the surfaces in the steam passages and valves are taken into account, and probably to a greater extent by future experimental knowledge of the dependence of condensation upon periodic time. All the writer wishes to suggest to the insured is that the engineer has to do something more than fix the cylinder diameter, the stroke, and number of the expansions if a high efficiency is required, and that the care bestowed on the details of a cylinder may influence the economy of the engine in no small degree.

AN OLD JAPANESE BRIDGE.

One of the great difficulties of spanning long rivers and streams in Japan, is that they are subject to floods, which sweep bridge piers and carry everything before them. In olden times a crossing was sometimes effected with ferry-boats, and in villages and country districts ropes were slung from side to side of the rivers, and passengers were transferred in a cradle traveling along it.

Throughout the country there are now thousands of bridges of long span, built of iron and timber. The illustration on page 506 is from a photograph of one of the famous old bridges in Japan, a model of which was exhibited a year ago at the Chicago Exposition. The bridge was built over the Kurobe River, in Aimoto Village, in the province of Etchin; it has therefore been known as Aimoto-bashi (Love Bridge). The bridge site was chosen in 1655 at a narrow point of the river, and the first structure erected. Since that time it has been renewed every 20 or 30 years, with no change in the design. Last year, however, it was replaced by a new bridge, consisting of wooden ribs, of 160 ft. span. The last bridge of the old type was constructed in 1863, and lasted more than 25 years, though the timbers were not protected. This bridge, in common with the other old bridges in Japan, was built on the cantilever principle, as shown in the engraving. The superstructure rested on the natural rock. The total length was 206 ft., the central span being 150 ft., with beam bridges of 23 ft. on each side. The length of the bridge at the middle of the stream was 50 ft. The six cantilevers of 1 ft. 5 in. × 1 ft. 1 in. timbers projected from each side, gradually approaching each other, until the intermediate span was 50 ft.

This was then spanned by three beams of 2 ft. 2 in. × 1 ft. 1 in., and the planking laid on them. The slope of the cantilevers was 1 in 2½. The bamboo baskets filled with stones, in the foreground of the picture, are called *jakago* (snake baskets), and they are used as protective works for river banks, being still found on the shores of some of the Japanese rivers.

Bridges similar in construction to this one are to be seen in many parts of Japan, though their spans are not as long as this. Modern cantilever bridges of iron and steel are built on this same principle, though, of course, such a structure as this requires more timber than where trussing is resorted to. It is, however, an interesting specimen of bridge architecture as practised in old Japan.

THE ENIGMAS OF THE ELEMENTS.

The following interesting discussion on this subject forms part of the annual address of the President of the British Association the Marquis of Salisbury delivered at the recent meeting held in Oxford:

"Of the scientific enigmas which still, at the end of the nineteenth century, defy solution, the nature and origin of what are called the elements is the most notable. It is not, perhaps, easy to give a precise logical reason for the feeling that the existence of our 65 elements is a strange anomaly and conceals some much simpler state of facts. But the conviction is irresistible. We cannot conceive, on any possible doctrine of cosmogony, how these 65 elements came into existence. A third of them form the substance of this planet. Another third are useful, but somewhat rare. The remaining third are curiosities scattered haphazard, but very scantily, over the globe, with no other apparent function but to provide occupation for the collector and the chemist. Some of them are so like each other that only a chemist can tell them apart; others differ immeasurably from each other in every conceivable particular. In cohesion, in weight, in conductivity, in melting point, in chemical proclivities, they vary in every degree. They seem to have as much relation to each other as the pebbles on a sea beach, or the contents of an ancient lumber room. Whether you believe that creation was the work of design or of inconscient law, it is equally difficult to imagine how this random collection of dissimilar materials came together. Many have been the attempts to solve this enigma; but up till now they have left it more impenetrable than before. A conviction that here was something to discover lay beneath the persistent belief in the possibility of the transmutation of other metals into gold, which brought the alchemy of the Middle Ages into being. When the immortal discovery of Dalton established that the atoms of each of these elements have a special weight of their own, and that consequently they combine in fixed ponderable proportions from which they never depart, it renewed the hope that some common origin of the elements was in sight. The theory was advanced that all these weights were multiples of the weight of hydrogen—in other words, that each elementary atom was only a greater or a smaller number of hydrogen atoms compacted by some strange machinery into one. The most elaborate analyses, conducted by chemists of the highest eminence—conspicuously by the illustrious Stas—were directed to the question whether there was any trace in fact of the theoretic idea that the atoms of each element consist of so many atoms or even of so many half atoms of hydrogen. But the reply of the laboratories has always been clear and certain—that there is not in the facts the faintest foundation for such a theory.

"Then came the discovery of the spectral analysis, and men thought that with an instrument of such inconceivable delicacy we should at last find out something as to the nature of the atom. The result has been wholly disappointing. Spectral analysis in the hands of Dr. Huggins and Mr. Lockyer and others has taught us things of which the world little expected to be told. We have been enabled to measure the speed with which clouds of blazing hydrogen course across the surface of the sun; we have learned the pace—the fabulous pace—at which the most familiar stars have been for ages approaching to or receding from our planet, without apparently affecting the proportions of the patterns which, as far as historical record goes back, they have always delineated on the evening sky. We have received some information about the elementary atoms themselves. We have learned that each sort of atom when heated strikes upon the ether a vibration, or set of vibrations, whose rate is all its own; and that no one atom or combination of atoms in producing its own spectrum encroaches even to the extent of a single line upon the spectrum that is peculiar to its neighbor. We have learned that the elements which exist in the stars, and specially in the sun, are mainly those with which we are familiar upon earth. There are a few lines in excess to which we can give no terrestrial name; and there are some still more puzzling gaps in our list. It is a great aggravation of the mystery which besets the question of the elements that among the lines which are absent from the spectrum of the sun those of nitrogen and oxygen stand first. Oxygen constitutes the largest portion of the

solid and liquid substance of our planet, so far as we know it; and nitrogen is very far the predominant constituent of our atmosphere. If the earth is a detached bit whirled off the mass of the sun, as cosmogonists love to tell us, how comes it that in leaving the sun we cleaned him out so completely of his nitrogen and oxygen that not a trace of these gases remains behind to be discovered even by the sensitive vision of the spectroscope? All these things the discovery of spectrum analysis has added to our knowledge; but it has left us as ignorant as ever as to the nature of the capricious differences which separate the atoms from each other, or the cause to which those differences are due.

"In the last few years the same enigma has been approached from another point of view by Professor Mendeléeff. The periodic law which he has discovered reflects on him all the honor that can be earned by ingenious, laborious, and successful research. He has shown that this perplexing list of elements can be divided into families of about seven, speaking very roughly; that those families all resemble each other in this, that as to weight, volume, heat, and laws of combination the members of each family are ranked among themselves in obedience to the same rule. Each family differs from the others; but each internally is constructed upon the same plan. It was a strange discovery—strangest of all in its manifest defects. For in the plan of his families there were blanks left; places not filled up because the properly constituted elements required according to his theory had not been found to fill them. For the moment their absence seemed a weakness in the professor's idea, and gave an arbitrary aspect to his scheme. But the weakness was turned into strength when, to the astonishment of the scientific world, three of the elements which were missing made their appearance in answer to his call. He had described beforehand the qualities they ought to have; and gallium, germanium, and scandium, when they were discovered shortly after the publication of his theory, were found to be duly clothed with the qualities he required in each. This remarkable confirmation has left Mendeléeff's periodic law in an unassailable position. But it has rather thickened than dissipated the mystery which hangs over the elements.

"The discovery of these co-ordinate families dimly points to some identical origin, without suggesting the method of their genesis or the nature of their common parentage. If they were organic beings all our difficulties would be solved by muttering the comfortable word 'evolution'—one of those indefinite words from time to time vouchsafed to humanity, which have the gift of alleviating so many perplexities and masking so many gaps in our knowledge. But the families of elementary atoms do not breed; and we cannot therefore ascribe their ordered difference to accidental variations perpetuated by heredity under the influence of natural selection. The rarity of iodine, and the abundance of its sister chlorine, cannot be attributed to the survival of the fittest in the struggle for existence. We cannot account for the minute difference which persistently distinguishes nickel from cobalt by ascribing it to the recent inheritance by one of them of an advantageous variation from the parent stock.

"The upshot is, that all these successive triumphs of research, Dalton's, Kirchoff's, Mendeléeff's, greatly as they have added to our store of knowledge, have gone but little way to solve the problems which the elementary atoms have for centuries presented to mankind. What the atom of each element is, whether it is a movement, or a thing, or a vortex, or a point having inertia, whether there is any limit to its divisibility, and, if so, how that limit is imposed, whether the long list of elements is final, or whether any of them have any common origin—all these questions remain surrounded by a darkness as profound as ever. The dream which lured the alchemists to their tedious labors, and which may be said to have called chemistry into being, has assuredly not been realized, but it has not yet been refuted. The boundary of our knowledge in this direction remains where it was many centuries ago.

INSCRUTABILITY OF THE ETHER.

"The next discussion to which I should look in order to find unsolved riddles which have hitherto defied the scrutiny of science would be the question of what is called the ether. The ether occupies a highly anomalous position in the world of science. It may be described as a half-discovered entity. I dare not use any less pedantic word than entity to designate it, for it would be a great exaggeration of our knowledge if I were to speak of it as a body or even as a substance. When, nearly a century ago, Young and Fresnel discovered that the motions of an incandescent particle were conveyed to our eyes by undulation, it followed that between our eyes and the particle there must be something to undulate. In order to furnish that something the notion of the ether was conceived, and for more than two generations the main, if not the only, function of the word 'ether' has been to furnish a nominative case to the verb 'to undulate.' Lately our conception of this entity has received a notable extension. One of the most brilliant of the services which Professor Maxwell has rendered to science has been the discovery that the figure which expressed the velocity of light also expressed the multiplier required to change the measure of static or passive electricity into that of dynamic or active electricity. The interpretation reasonably affixed to this discovery is that, as light and the electric impulse move approximately at the same rate through space, it is probable that the undulations which convey them are undulations of the same medium. And as induced electricity penetrates through everything, or nearly everything, it follows that the ether through which its undulations are propagated must pervade all space, whether empty or full, whether occupied by opaque matter or transparent matter, or by no matter at all. The attractive experiments by which the late Professor Herz illustrated the electric vibrations of the ether will only be alluded to by me, in order that I may express the regret deeply and generally felt that death should have terminated prematurely the scientific career which had begun with such brilliant promise and such fruitful achievements. But the mystery of the ether, though it has been made more fascinating by these discoveries, remains even more inscrutable than before. Of this all-pervading entity we know absolutely nothing except this one fact, that it can be made to undulate. Whether, outside the influence of matter on the motion of its waves, ether has any effect on matter or matter upon it, is absolutely unknown. And even its solitary function of undulating ether performs in an abnormal fashion which has caused infinite perplexity. All fluids that we know transmit any blow they have received by waves which undulate backward and forward in the path of their own advance. The ether undulates athwart the path of the wave's advance. The genius of Lord Kelvin has recently discovered what he terms a labile state of equilibrium, in which a fluid that is infinite in its extent may exist, and may undulate in this eccentric fashion without outraging the laws of mathematics. I am no mathematician, and I cannot judge whether this reconciliation of the action of the ether with mechanical law is to be looked upon as a permanent solution of the question, or is only what diplomatists call a *modus vivendi*. In any case it leaves our knowledge of the ether in a very rudimentary condition. It has no known qualities except one, and that quality is in the highest degree anomalous and inscrutable. The extended conception which enables us to recognize ethereal waves in the vibrations of electricity has added infinite attraction to the study of those waves, but it carries its own difficulties with it. It is not easy to fit in the theory of electrical ether waves with the phenomena of positive and negative electricity, and as to the true significance and cause of those counteracting and complementary forces, to which we give the provisional names of negative and positive, we know about as much now as Franklin knew a century and a half ago."

TWO TYPES OF LOCOMOTIVES FOR BRAZIL.

The Brooks Locomotive Works are just completing an order for 60 locomotives for the Brazil Central Railway (*Estrada de Ferro Central do Brazil*). Two types of locomotives are used in filling the order, and these are well shown in the accompanying engravings taken from photographs. The larger engine is of the *Mastodon* type, and has cylinders 21 in. in diameter with a piston stroke of 26 in. The drivers are 54 in. in diameter, on 9 in. axles. The inside diameter of the smallest boiler ring is 68 in. The shell is made of steel $\frac{11}{16}$ in. thick. The fire box is 9 ft. 6 in. long and 3 ft. $2\frac{1}{8}$ in. wide inside the mud ring, and is of a modified Belpaire type. The lines are curved in accordance with an improved design of Mr. John Player's, the mechanical engineer for the company. Both the wagon top and crown sheet are arched, and radial stays are used. It is somewhat unusual for American builders to use copper for the fire-boxes, but that metal has been used in these engines, the tube sheet being $\frac{13}{16}$ in. thick and the fire-box $\frac{11}{16}$ in.

The estimated weight of the engine in working order is 170,000 lbs., of which 30,000 lbs. is on the truck and 140,000 lbs. on the drivers. The total weight of the engine and tender is put at 252,000 lbs.

The engine is somewhat more highly finished than American locomotives of the present day, and has a considerable quantity of brasswork and bright paint. Brass casings are used on the sand-box, dome, steam-chests and cylinders, and the same metal is used for the bands of the boiler lagging, as well

as the edges of the headlight stand and running boards. Two brass bands encircle the stack, and the hand-rails are brass tubing. Green is the color used on all painted portions of the engine and tender, and this is relieved by gold-leaf stripings.

The buffers at the front end are hinged, so that they can be folded back when not in use.

The engine is equipped with the Le Chatelier water-brake, as well as with the latest designs of Westinghouse air-brake and the American driver-brake.

It is intended that two firemen shall be employed, and they are protected from the weather by the hood projecting over the gangway, as shown.

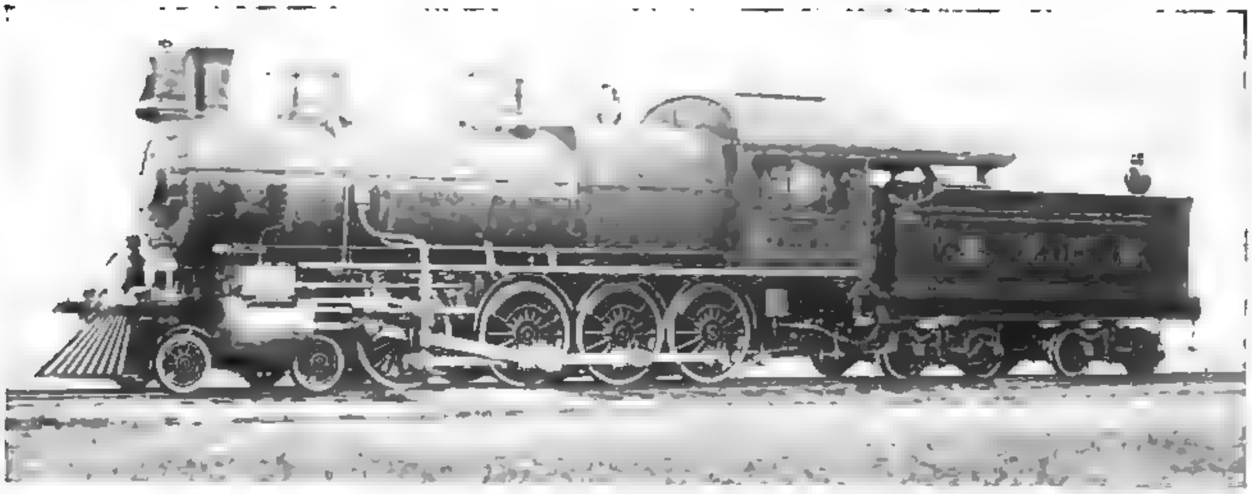
The other locomotive illustrated is of the suburban type of modified Forney design. The cylinders are 18 in. in diameter, with a piston stroke of 24 in. The drivers are 62 in. in diameter; the inside diameter of the smallest boiler ring is 58 in., and the fire-box is 8 ft. 0 in. long and 3 ft. 2¼ in. wide inside the mud ring The total estimated weight of the engine in working order is 176,000 lbs, distributed as follows: on the two-wheeled engine truck, 16,000 lbs.; on the six-wheeled truck, 50,000 lbs.; and on the drivers, 110,000 lbs.

It will be seen from the engraving that the boiler of this engine is of the wagon-top type. Both engines are fitted with pumps for feeding the boiler. A peculiarity of the cab is the monitor roof and side lights in the upper deck, that has an external appearance somewhat resembling passenger-car construction. These engines are equipped with the Westinghouse air-brake, the pump for which is placed on the left-hand side of the boiler at the back end of the shell. The American Brake Company's horizontal type of locomotive brake is also used.

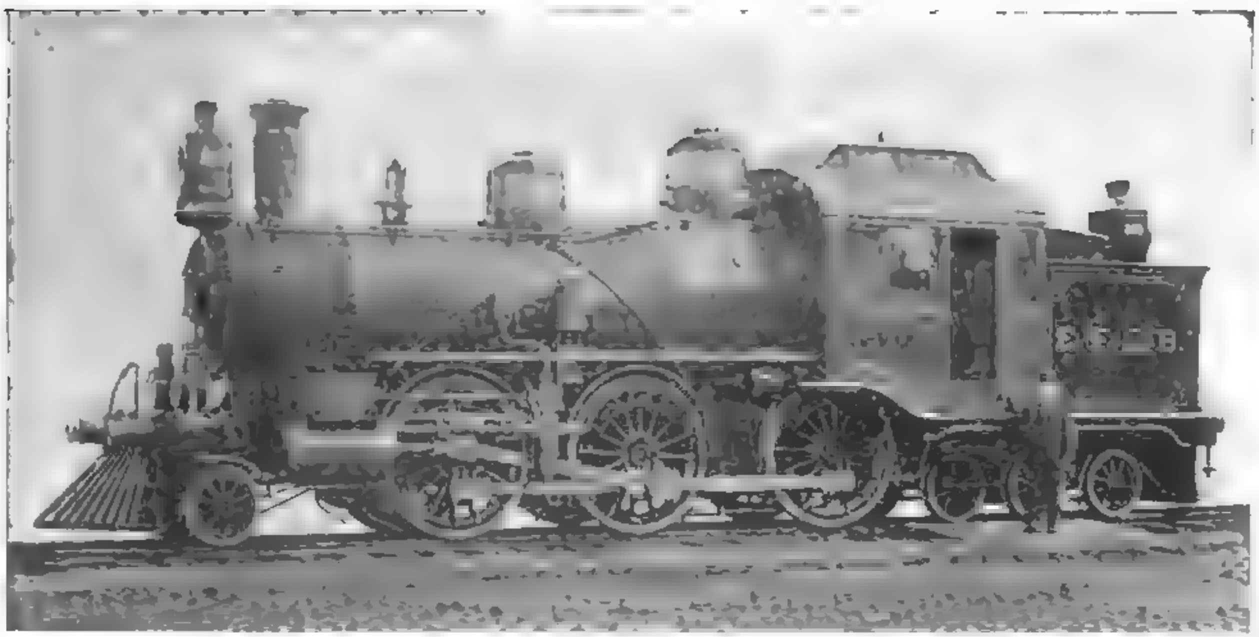
A special feature of these engines lies in the use of the Pintsch gas headlights. The locomotives, being double enders, are equipped with two 20-in. headlights, supplied with a powerful Argand burner, one headlight being located above the smoke-arch and one on top of the tender tank. The signal lights, of which there are four, are also arranged for burning gas, and the cab is illuminated by a small Pintsch lamp, protected by a metal-covered globe, a slot in which permits the light to shine only on the faces of the gauges. The gas supply is carried in a tank hung below the cab floor between the side frames that carry the tender.

Recent tests of the efficiency of these headlights in the Hoboken yards of the Delaware, Lackawanna & Western Railroad gave excellent results. The application of Pintsch gas to locomotive signals and headlights is not new, for it has been used in Europe and South America for several years with excellent results.

Attention has frequently been called, in the pages of the American Engineer, to the dangerous construction of the ordinary type of steps that are used on the engines and tenders of American locomotives; and while we cannot be cited as being over partial to the English locomotive, we have advocated that the steps used on them were far superior to our



MASTODON LOCOMOTIVE FOR THE CENTRAL RAILWAY OF BRAZIL. BUILT BY THE BROOKS LOCOMOTIVE WORKS, DUNKIRK, N Y.



SUBURBAN LOCOMOTIVE FOR THE CENTRAL RAILWAY OF BRAZIL BUILT BY THE BROOKS LOCOMOTIVE WORKS, DUNKIRK, N. Y.

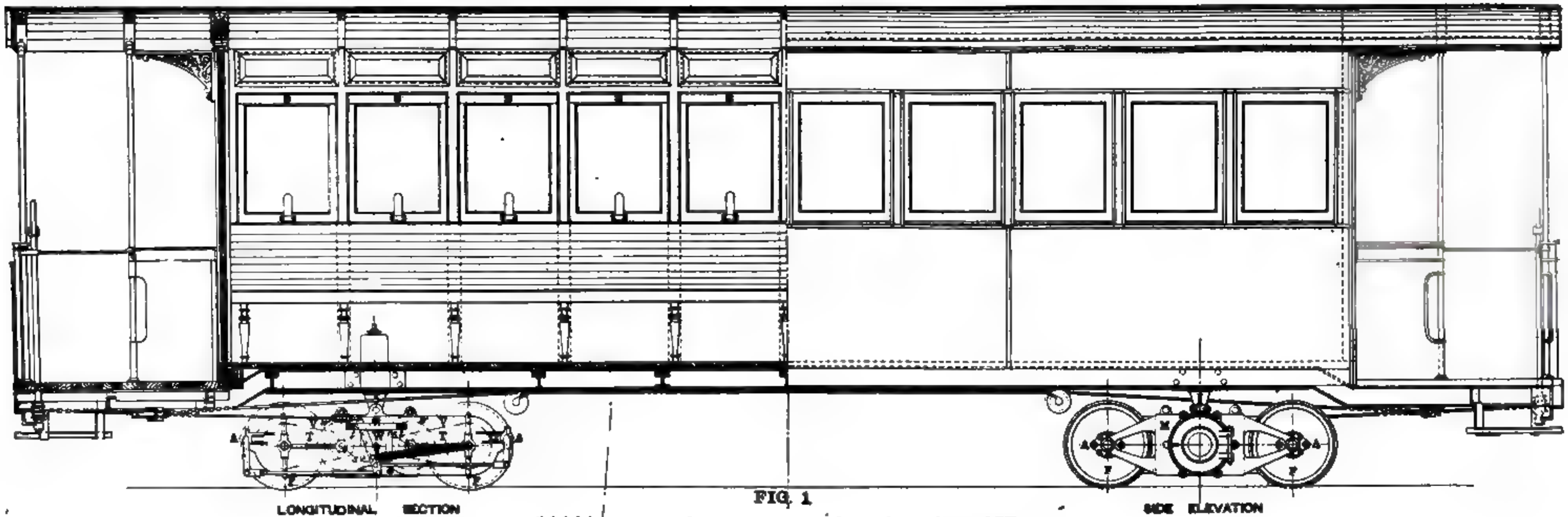


FIG. 1

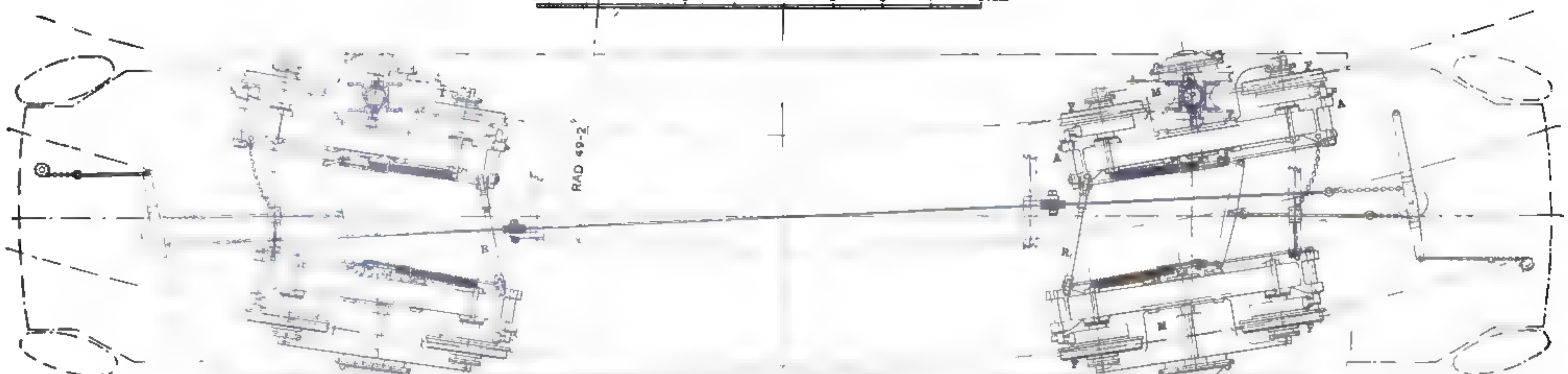


FIG. 2.

BICYCLETTE ELECTRIC PASSENGER CAR, DESIGNED BY MR. CHARLES BROWN, OF BASLE, SWITZERLAND.

own. It is with pleasure that we note the broad and well-protected step on the tender of the *Mastodon* locomotive, as showing that it is at least possible to have a safe step on an American locomotive. These engines are, perhaps, the most notable examples of engine construction that have been turned out of American shops during the current year, and we shall await reports of their performances in the southern country with great interest.

BROWN'S BICYCLETTE ELECTRIC CAR.

Last month we published extracts and descriptions taken from an American patent granted to Mr. Charles Brown, of Basle, Switzerland, for a novel plan for electric cars. The engravings herewith are made from the working drawings, for which we are indebted to him. As persons who are familiar with patent drawings know, they seldom represent the construction of mechanism in the complete form which it must assume before it is perfected. The drawings herewith show the design of the car as it has been constructed, and which possesses some very novel features. At the risk of repeating what was published last month, some description will here be given in order to make the construction of the car and the engravings understood.

The car, as will be seen, has eight wheels. These are attached to four independent truck frames, the two wheels in tandem, on each side of each group of four, being mounted on separate frames, having jointed connections with the car body, whereby each pair of such wheels are permitted to adapt themselves in position to curves and vertical irregularities in the track, independently of the other wheels. Each tandem frame is provided with an independent motor. This is located between the two tandem wheels, with which it is connected by suitable gearing. The motor and gearing connecting it with the wheels are enclosed in a casing which forms a portion of the tandem frame.

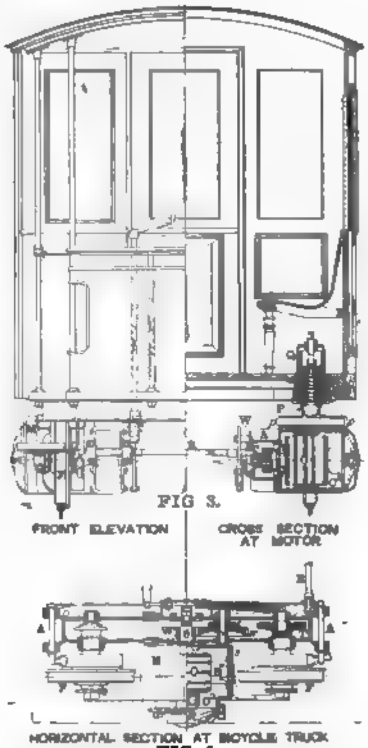


FIG. 4.

BROWN'S BICYCLETTE CAR.

In the drawing *F F* are the wheels and *A A* their frames, with casings *M M* for the electric motors, of which *B*, in fig. 4, is a field magnet, *C* an armature, *C'* the collector or commutator. Upon the inner end of each armature shaft *S* is mounted a pinion, *W*, which gears into wheels *w w* on shafts *s s*. On the inner ends of these shafts and the axles of the wheels *F F* sprocket wheels *T T* and *t t* are mounted, which are connected by chain belts *V V*, shown by dotted lines in the left-hand truck of fig. 1. The manner in which the motion of the motor is thereby communicated to the wheels *F F* is obvious.

The outer portion of the tandem frames at the middle of its upper side carries what may be called a cylindrical plunger, fig. 3, which is pivotally connected to the frame by a pin, *p p*, so that the frame can vibrate vertically about this pin. The plunger fits into a corresponding case, *Q*, attached to the body frame, and can turn in it about its vertical axis. The tandem frames have, therefore, a universal movement vertically about the pin *p*, and horizontally about the axis of the plunger *Q*. Suitable spiral springs are contained in the plunger, as shown in the sectional view in fig. 3, which support the weight of the car body. Each pair of tandem frames are connected together by a tie-bar, *R*, which is attached to the frames at each end by a universal joint, so that it and the frames can adjust themselves to any position.

Of this car Mr. Brown says: "If accumulator traction is to come up, this will, I hope, help materially, as it must reduce the power consumed to a minimum, and this is all-important in accumulator traction, as the power in store is a fixed quantity. This car is furnished, moreover, with a very convenient place for the batteries under the car body, between the fore and aft bicyclettes—the place under the seats is very inconvenient, and damages the construction of the car very seriously. The bicyclette permits the construction of cars of any size or capacity, and the tendency just now is in the direction of larger cars. The use of Hyatt's bearings would also reduce the amount of power consumed by at least, I should say, 25 per cent.

"From a constructive point of view the four bicyclettes are absolutely identical, and can be manufactured in numbers at a low figure, and they are entirely irrespective of the car they are to serve under. If any one becomes defective, it can be replaced in a few minutes without disturbing the three others. Further, the platform is only 2 ft. from rail-level, a great facility for entering and leaving the car, saving time and preventing accidents.

"The wheels are much smaller in diameter than is the case with the American motor cars, being only 20 in. instead of 32 in. or 34 in., hence much less tendency to jump the track.

"The rail-joints (the damage to the rail-joints is very serious with the heavy motor cars) would suffer less than with the two-axled cars, these being only one-half the load on each wheel in the case of the bicyclette, and thus there is the softening action of the bogie, as the car body is only lifted one-half so high in going over an obstacle on the rails, thus reducing the force of the blow to one-fourth of that in the case of the two-axled cars.

"The power required will not exceed one-half that now used. This is a very important point in the case of accumulator cars. I hope to be able to run a whole day with one charge."

RUSSIAN ENGINEERING NOTES.

A correspondent in Siberia has sent us the following notes relative to the engineering work that is being done in the Russian Empire. Railroad work is the predominating feature, though the government is fast adding to its effective navy, as evidenced by the new vessel which we illustrate, and which is being built at St. Petersburg.

A Connection of the Pacific with the Arctic Ocean.—The Committee of the Siberian Railroad, presided over by the successor to the throne, the Czarewitch Nicolas, has made an appropriation for survey for a new railway from Perm to Kotlas, which is, however, located in European Russia, but will soon be connected with the Great Siberian Railway system. The survey for this line is under the control of a commission of four members: two from the Ministry of Finance and two from the new Ministry of Agriculture, presided over by a member from the Ministry of Way Communications, Mr. Tolmacheff, C.E. The new railway starting from Perm, the actual terminus of the Oural Railway, which is to be connected with the Siberian Railroad by a branch from Ekaterinbourg to Chelabinsk, now in course of construction, will run westerly to Viatka, and thence northwesterly to Kotlas near the junction of the Nichehda with the North Dwina, the latter river being an old waterway to Archangel, the oldest Russian harbor on the White Sea. The Perm-Kotlas Line, in connecting Siberian Railroad with the White Sea, will put the Pacific in direct communication with the Arctic Ocean.

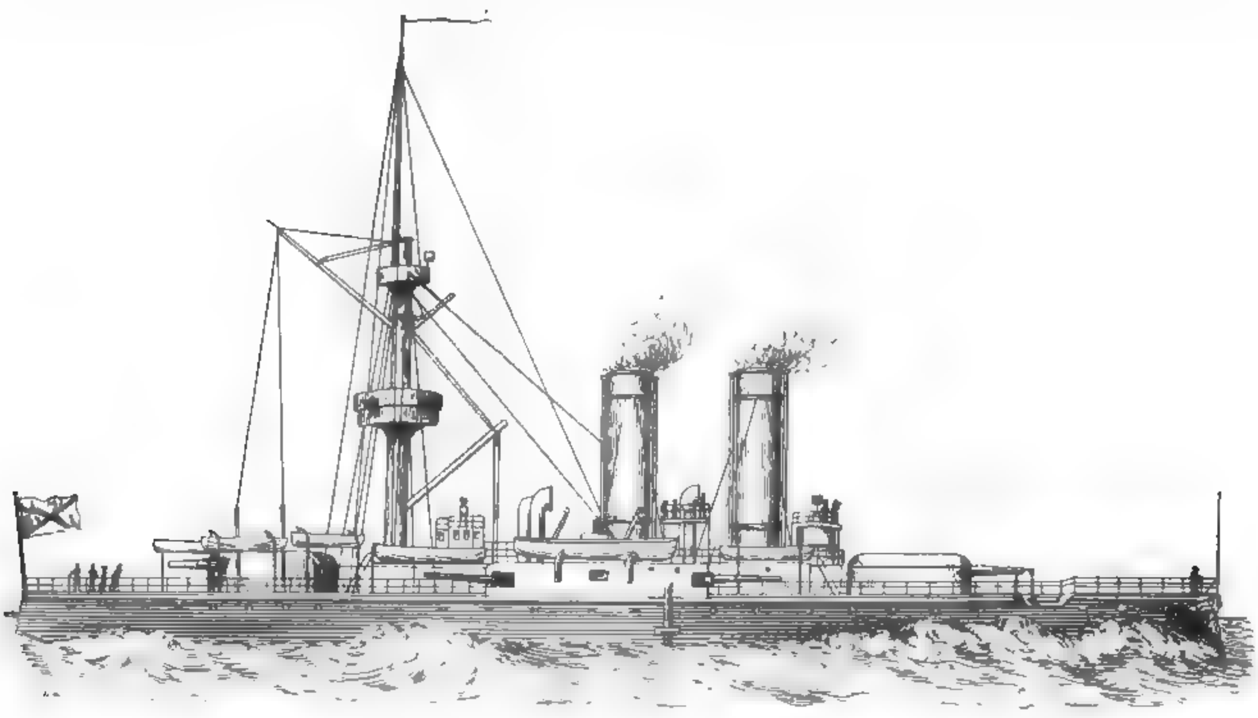
A New Connection with the White Sea.—While the principal seaports for Russian foreign traffic as well as for its navy are still upon the Baltic, that body of water is becoming more and more an inland sea of the German Empire, and this will be especially the case when the North Sea fleet can act with the Baltic fleet by way of the North Sea-Baltic ship canal. For this reason the Russian Government and the commercial public are turning their attention to the White Sea, and Archangel as a seaport, which from the fifteenth century was the principal outlet for Russian traffic, and has lost its importance only since the eighteenth century. As a result of this the Moskova-Yaroslar-Vologia Railroad Company (whose gauge is 3 ft. 6 in.) has received a grant to extend its line to Astrakhan, forming the Vologda-Astrakhan Division. The surveys and location were made last summer.

The Proposed Extension of the Transcaspian Railroad.—The Transcaspian Railroad, starting at Ouzoun Ada, on the Caspian Sea, crossing the Amou-Daria with a timber bridge,

and going through Bokhara to Samarkand (an ancient capital of Timour), 896 miles long, is now to be extended into the heart of the producing country of the Fergana territory. A party in charge of Mr. Sakhanski, C.E., has been sent to Russian Turkestan to survey the country in three directions: 1. Samarkand-Djisak-Begorat, on Sir-Daria River; 2. Andijan-Marghelan-Kokand-Begorat; 3. Tashkent-Begorat. When the survey and location are completed the construction of a main line from Samarkand to Begorat will be commenced. It is expected that the actual construction will begin in from two and one-half to three years.

The Russian Commercial Fleet.—The Russian Custom Department has just published a "List of Steamers of the Russian Commercial Fleet" as it stood on January 1, 1894. According to this list the fleet in outside seas consists of 203 steamers, the total tonnage of which is 109,872 tons. These steamers are distributed as follows: In the Black Sea, 146 steamers with a tonnage of 89,100; in the Baltic Sea, 48 steamers with a tonnage of 18,690; and in the White Sea, 9 steamers whose tonnage is 1,992. Of all the 203 steamers, only 39, or 20 per cent. of the whole, have been built in Russia. There are in addition to these, in the Caspian Sea, 123 commercial steamers, having a tonnage of 53,559, of which 58 steamers, or 48 per cent. of the whole, have been built in Russia.

The New Russian Armored Ship "Admiral Seniavin."—The Russian Baltic armored fleet was increased in July by the launching of a new two-turret, coast-defense armored ship, the *Admiral Seniavin*, illustrated by the accompanying engraving. The hull was built at the government works of the New Admiralty, at St. Petersburg. The first keel-plate was riveted in the yard in July, 1892. The official inauguration of works was in April, 1893, when 550 tons of steel had been received, the whole weight of the hull being 1,500 tons. The hull is built according to the drawings of Mr. Goulaief, engineer, and under the superintendence of Mr. Yakovleu, engineer. The construction has occupied more than 23 months, much more than the construction of the sister armored ship, *Admiral Ushakor*, at the Baltic Works, in St. Petersburg, which with the engine took only 15 months. The hull of *Admiral Seniavin* is made from the Siemens-Martin mild steel, furnished to the Admiralty by the Izhova Works, and was previously tested. The double bottom consists of 150 compartments in the submerged part; in addition to these there are one longitudinal and eight transversal bulkheads carried up to the armored deck. There are three decks, the lower of which is of steel, all being flat and without camber. The middle section of the hull is flat and has two steel bilge keels, so as to secure greater stability. The bow and stern are both sharp, the former being provided with a cast-steel ram, extending 6 ft. beyond the deck line. While the stern is sharp at the water-line, it rounds out at the upper deck, forming a protected space for the rudder and propellers. The great bow and stern pieces were ordered from England. Their weight is 30 tons. The stern piece is cast in one piece, and encloses with the rudder-post, pivots and frame. The height of the deck above the water is not great, being about 10 ft., so that, in order to protect the fore turret from inundations when going against the wind and waves, a sickle-formed cut-water is adopted. Concerning the general construction and particulars of the hull, this new armored ship is quite analogous to the English armored ships *Nile* and *Trafalgar*. The dimensions for a coast defense ship are large: Extreme length, 283 ft. 6 in.; length on water-line, 278 ft., and length between perpendiculars, 264 ft.; breadth on water line, 52 ft.; mean draft, 17 ft.; displacement, 4,126 tons. The armored defense consists of steel and iron plates distributed in the hull in the following manner: The belt, 8 ft. broad, runs one-third the



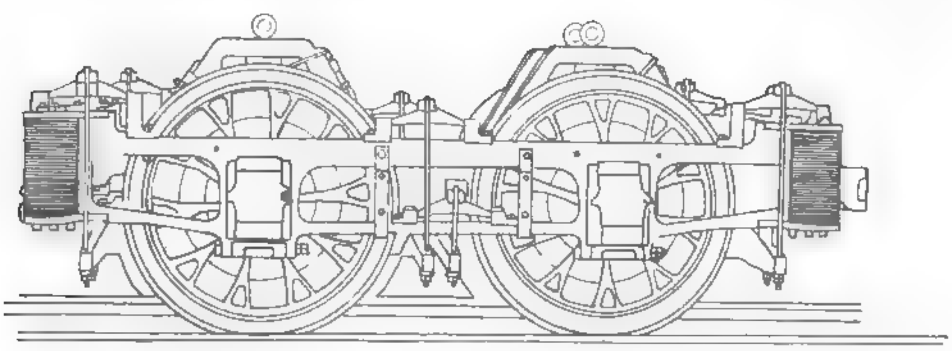
THE NEW RUSSIAN ARMORED BATTLESHIP THE "ADMIRAL SENIAVIN."

length of the water-line, and extends 3 ft. above it; the extremities of the belt are joined by transverse belts of the same thickness; a convex steel deck is built in along the lower edge of the belt, and extends throughout the whole length of the hull, thus protecting the "vital parts" of the ship from vertical fire. The openings of the boiler and engine compartments are protected by armor; the artillery is also protected, the 10-in. guns being placed in the turret. For protecting the commanding officer an armored conning tower is located forward on the upper works. The greatest thickness of the armor in the middle of the belt, in turrets and conning tower, is 10 in. The armor plates were made at the government works of Izhova and Oboukhov. The armament of the ship consists of 30 guns of various sizes and designs. Four 10 in. 40-caliber guns are placed in two armored, revolving turrets, which, for reduction of weight, are oval-shaped. That portion of the turret that drops below the upper deck is cylindrical and set on an armored tube containing the ammunition hoist for the turret. Four rapid-fire guns, of the newly adopted Canet system, are placed in the citadel between the turrets. The angle of fire of each of these guns is more than 90° forward or aft of the broadside, according to its location, so that each pair can fire direct ahead or astern. Twenty small rapid-fire guns of the Hotchkiss system, 47–37 millimeters, and two Baranov guns of 2½ in., are placed on the main deck. The torpedo armament consists of four torpedo tubes, two torpedo launches, a set of protecting nets, and two Mangin electric search-lights, one on the conning tower and one on

the mast. There are two separate triple-expansion engines built by the English firm of Messrs. Maudslay & Field. Steam is furnished by four double water tubs, Belville boilers, carrying a working pressure of 180 lbs. per square inch. The indicated H.P. developed by both engines will be 4,250, and the speed of the ship will be from 16 to 17 knots. The coal bunkers will carry 220 tons, but this stock can be increased by 180 tons more. The ventilators of boiler and engine-rooms are grated. There are 10 auxiliary boats, two of which are steam launches, and two bow anchors of Martin's system. There is only one mast. The ship is registered as a first-class vessel.

THE BALTIMORE & OHIO'S BELT LINE.

The work on the electrical plant being erected to haul the trains of the Baltimore & Ohio Railroad through the Belt Line tunnel is being pushed to an early completion. The locomotives are finished, and the machinery to generate the electricity is complete and ready for erection, and the power-house is well under way, and it is fully expected that before January 1, 1895, trains will be hauled through the brilliantly lighted tunnel by powerful electric locomotives. The locomotives consist of two trucks, each truck having two axles, and on each axle is mounted a 300-H.P. motor. The motors are gearless, and are supported on springs resting on the frames of the locomotive truck. This method of suspension leaves the wheels free to adjust themselves to the irregularities of the roadbed, and consequently tends to diminish the wear of both tracks and motors. The motor fields are of iron-clad type, having each separate wingings imbedded in a mica-lined slot cut into the curved body of the laminated iron armature. The axles of the locomotive pass through the hollow shaft on which the armatures are mounted. These shafts rest on the bearings of the motor frame, and are connected to the axles by universal couplings, which allow of freedom of motion in all directions. There are four sets of brushes to each commutator. The motors are controlled by means of series of paralleled controllers set up in the interior of the cab. The truck, suspended from journal boxes, is to be constructed of heavy beams, which will form the foundation for the locomotive cab, which is of sheet iron, of symmetrical design, and so curved off as to diminish the atmospheric resistance as far as possible. The interior is to be finished in hard wood, with two sliding doors at each side of cab, and windows so arranged as to permit an unobstructed view in all directions. There will be ample space in the cab for the motorman's movements, and will afford him considerably better protection than that usually vouchsafed the steam locomotive engineer.



TRUCK OF ELECTRIC LOCOMOTIVE FOR THE BALTIMORE & OHIO BELT LINE.

The drawing shown herewith is one of the two trucks, and it will be seen that when finished the complete locomotive will be an exceedingly massive piece of machinery, weighing at least 100 tons of 1,200 H.P. traction. It is fitted with air brakes, the air being compressed by a small auxiliary motor in the cab. The electrical air compressor will also operate the whistle. The regulation is such that the speed can be varied from nothing up to 35 or 40 miles per hour, and this can be increased if desired. For the work contemplated, however, 30 miles per hour will probably be the maximum.

The locomotives are to be used in this way: If a freight train is to be pushed through the tunnel, the motor switches behind the train and couples to it without stopping. It then pushes it steadily from the Camden Street end of the tunnel to the portal at Mount Royal Avenue, up a grade of about eight-tenths of one per cent.; then the steam locomotive is also put to work, and the two of them pull the train up the steeper grade to Huntington Avenue, where the electric motor is detached. For passenger work the electric motor will be coupled to the train at the lower or Lombard Street Station, and will be detached at the upper or Bolton Street Station.

As there will be no smoke in the tunnel, it will be possible to paint its interior white; and as it will be illuminated by about 2,000 incandescent lamps, it will not be necessary to light the lamps in the cars. The difference in comfort between the present plan of a smoky locomotive and a dark tunnel with the cars lighted by a few lamps, as compared with this plan, where there is no smoke, and where there will be brilliant outside illumination, can be easily imagined.

The overhead work necessary to generate the electric current to the locomotives has been specially designed, and will at once be erected. It is expected that the whole plant will be in operation by the middle of November or December 1, when trains will be regularly run through the tunnel. Professor Louis Duncan, of the Johns Hopkins, is the Electrical Engineer for the Baltimore & Ohio.

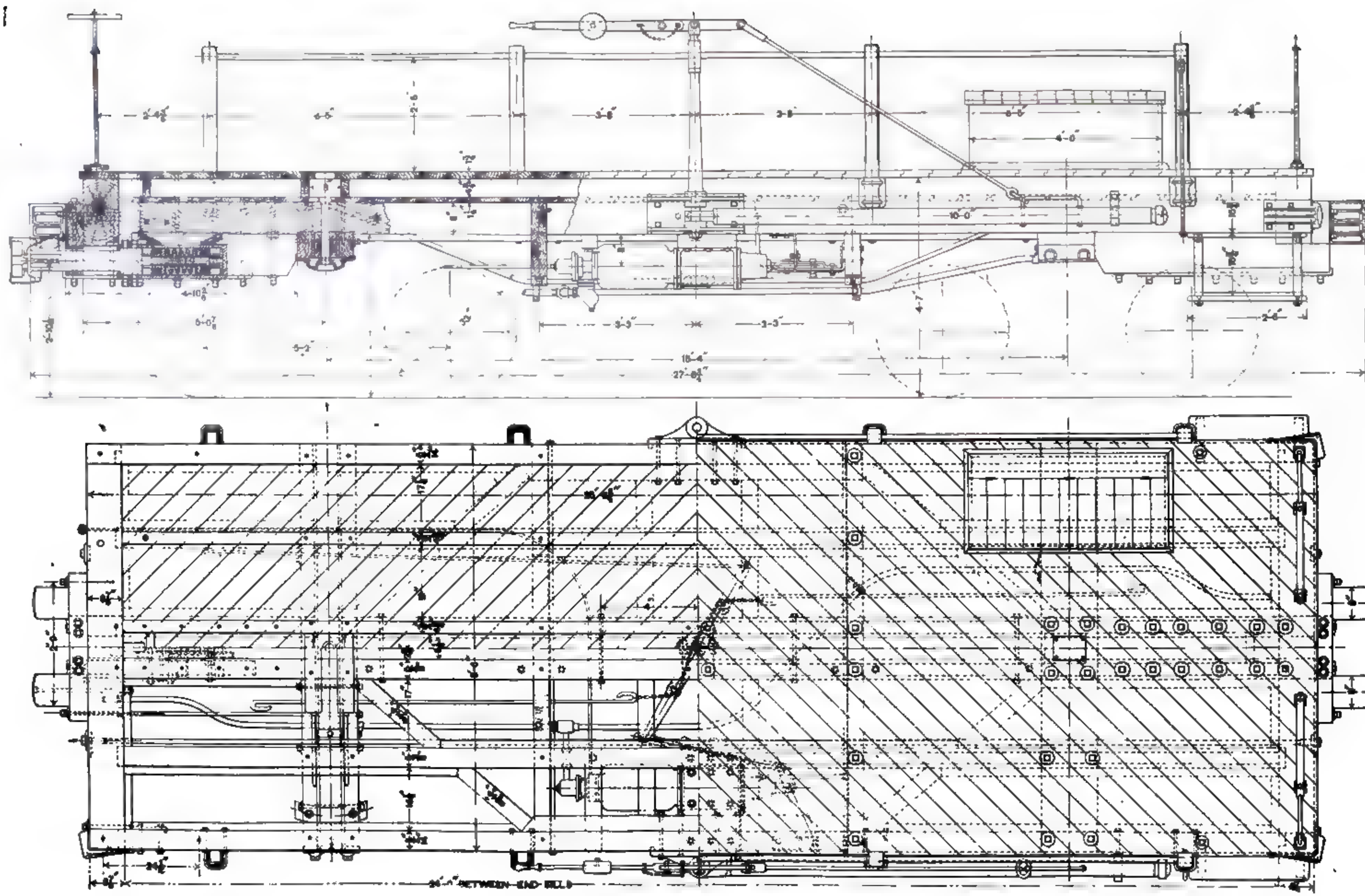
CHINESE RAILROADS.

The date of the first appearance of railroads in the Celestial Empire is in 1863 and 1864. At this time an Englishman, Sir Macdonald Stevenson, brought forward a project which came to no effect, in spite of the efforts of its promoters, for the formation of a company for the purpose of building railroads and large warehouses. Matters remained in *statu quo* until 1873, when the King of Belgium and the Duke of Sutherland combined in the formation of the Wo-sung Railroad Company. The circumstances which brought the final disaster to the company constituted a curious passage in the history of railroads, and are worth recalling.

Traffic between Shanghai and Wo-sung, which are about 9½ miles apart, is very important, and for a long time the necessity had been felt for providing means for transportation that would be more rapid than by river.

The promoters of the company after long negotiations secured a permit to build a road between Shanghai and Wo-sung, and profiting by this authorization, they built the road along the surveyed route. In the presence of this somewhat slight stretching of the actual permit, the Chinese officials held themselves aloof, neither approving nor disapproving. The line was, therefore, built in the midst of a thousand difficulties, due to the hostilities of the populace. The gauge of the road was 2½ ft., and the locomotives weighed about 33,000 lbs. The line was opened on July 1, 1875, but during the month of August a Chinaman was run over by the train and killed. This accident decided the fate of the company, for the Chinese officials, who were only waiting for an opportunity to interfere, said: "We gave you the permission to build a road, but there is nothing in it regarding rails, and your iron demons certainly cannot remain. You must not kill our people, and it is clear that such an accident which has just occurred must not be renewed." The company nevertheless continued operations for about a year, but it was finally compelled to yield and take up its rails, which, strange to relate, were utilized in the construction of the important line which was authorized to be built in the Island of Formosa.

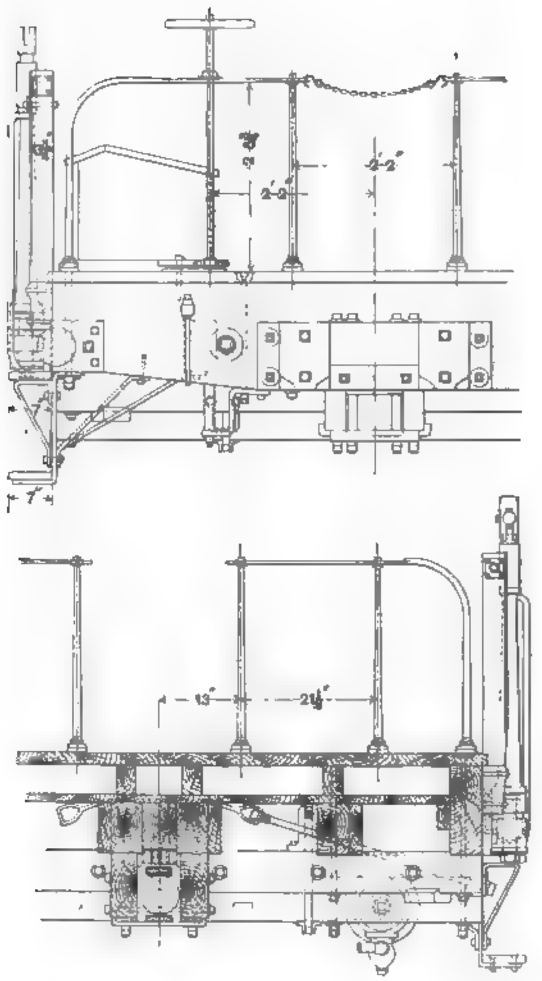
The second attempt was made 10 years later, and the theater of its operations was at the coal mines of Kai-Ping, in the Province of Pe-Chi-Li. The cost of transportation of coal from these mines was very high, in consequence of the necessity of hauling it in native wagons from the mine to the river. The engineers of the mine had been contemplating the substitution of a railroad for this primitive method of transportation for a long time, but the experience of the Wo-sung Company was not of such a nature as to encourage the trial. Fortunately the viceroy of the province, Li Hung Chang, was favorably disposed toward European ideas. They therefore con-



POLING CAR, NEW YORK, LAKE ERIE & WESTERN RAILROAD.

structed the locomotive by piecemeal, which was set up at the mine; at the same time they laid rails and replaced the wagons by lorry cars, and on one fine day the Viceroy was invited to inspect this new method of transportation. Li Hung Chang accepted the invitation, and was present with a numerous suite. They showed him the locomotive named the *Rocket of China*, and finally succeeded in getting him aboard of it. The engine thus made its first trip of 13½ miles, going and returning with the Viceroy aboard. On his return the latter publicly expressed his satisfaction. His example was eagerly followed, and the *Rocket* at once became popular. The cause was gained.

Thanks to this success the company soon obtained the franchise to extend its line to the sea. On this extension a track of 4 ft. 8½ in. gauge was laid. The capital was furnished by the promoters and the Chinese manufacturers, who were contented with the indirect benefits which the new line gave them for their dividend.



END ELEVATION AND SECTION OF POLING CAR, NEW YORK, LAKE ERIE & WESTERN RAILROAD.

The government in turn furnished the necessary funds for the construction of an extension reaching to Lan-Chow toward the north, and Tien-Tsin toward the west, and it was not long before it took complete control of the whole line. The matter of extending the line from Tien-Tsin to Pekin was also taken up, but the project was overwhelmed by great political and financial difficulties.

However that may be, works were set up at Tong-ku, near the port of Ta-ku, for discharging cars directly into the ships, and between Ton ku and Tien-Tsin. The rolling stock consists of English express locomotives weighing 60 to 70 tons.

The line between Tien-Tsin and its western terminus, Shang-Kwan, has a good passenger traffic, and carries a large quantity of merchandise, which could be only transported at the expense of great labor in springless wagons or on the backs of animals. There is no further opposition, and new extensions are received everywhere with favor. For all earth-work the Chinese workmen are well adapted, but up to the present time the engineers and machinists are English, the firemen are recruited from among the Chinese, and the matter of making engine-drivers of them is under consideration. It is probable that before long the staff will be European, probably English, for the business is exclusively in their hands, and they have the full control at Tai-Ping.—*Commerce*.

POLING CAR, NEW YORK, LAKE ERIE & WESTERN RAILROAD.

In making up trains where cars are run into a number of sidings, in station order, it is frequently necessary that they should be pushed into position by a locomotive running on another track from that upon which the car itself is traveling; when such cases arise it has been customary to use a heavy stick of timber, which the brakeman places against the front bumper of the locomotive and against the car, it acting as a strut or thrust piece to push the car. When the locomotive stopped, this naturally fell to the ground, and caused more or less trouble, with an occasional derailment, on account of its falling across the rails in front of the locomotive.

The New York, Lake Erie & Western Railroad have recently completed, at their shops at Susquehanna, a poling car, whose construction is shown in our accompanying engraving. This car is now in use in the Jersey City yards for the purpose which we have outlined. The car itself is of very heavy construction: the outside sills are 14 in. deep and 5 in. wide, in order that they may have sufficient strength to stand the thrust of the pole, which is hinged directly on them; the end sills are also particularly heavy, being 8½ in. wide by 14 in. in depth; the body bolsters are of the composite type, consisting of two pieces of 8½-in. × 6½-in. timbers, of a central piece of 5½ in. × 6½ in., and two plates of ⅜ in. × 6 in. iron laid between; the draft rigging is of the Graham design with Master Car Builders' standard coupler, as shown in the engraving. The car is equipped with air brakes in which the 3,000 lbs. of pressure is available in the brake cylinders, giving a total braking power of 35,000 lbs.

It will be noticed from the car section that there is a filling piece between the center sills. There is a double floor, the lower one being laid on the top of the 8-in. sills, which are the intermediate and center sills; this floor is 1¾ in. thick; on top of this there is another set of intermediate and center sills 4½ in. high by 3 in. thick, and on this the main floor of 1¾-in. flooring is laid diagonally.

A railing extends around the car to protect the workmen from being thrown off by sudden jerks and jars to which they are subjected. The tool-box is located at one end, and the pole is hinged, as we have already said, to the outside sills directly in the center. The method of operating the pole will be readily understood from the engraving; it has a free up-and-down motion about the pivotal point, where the eye at the heel is rounded to allow of a vertical motion; the outer end is swung from a counterweighted lever as shown. The man in charge raises or depresses the end of the lever, and pulls it in or out to adjust the point of the pole to the car to be pushed, and then, of course, has nothing to do but stand ready to check the weight as the engine slows down and the pushed car recedes.

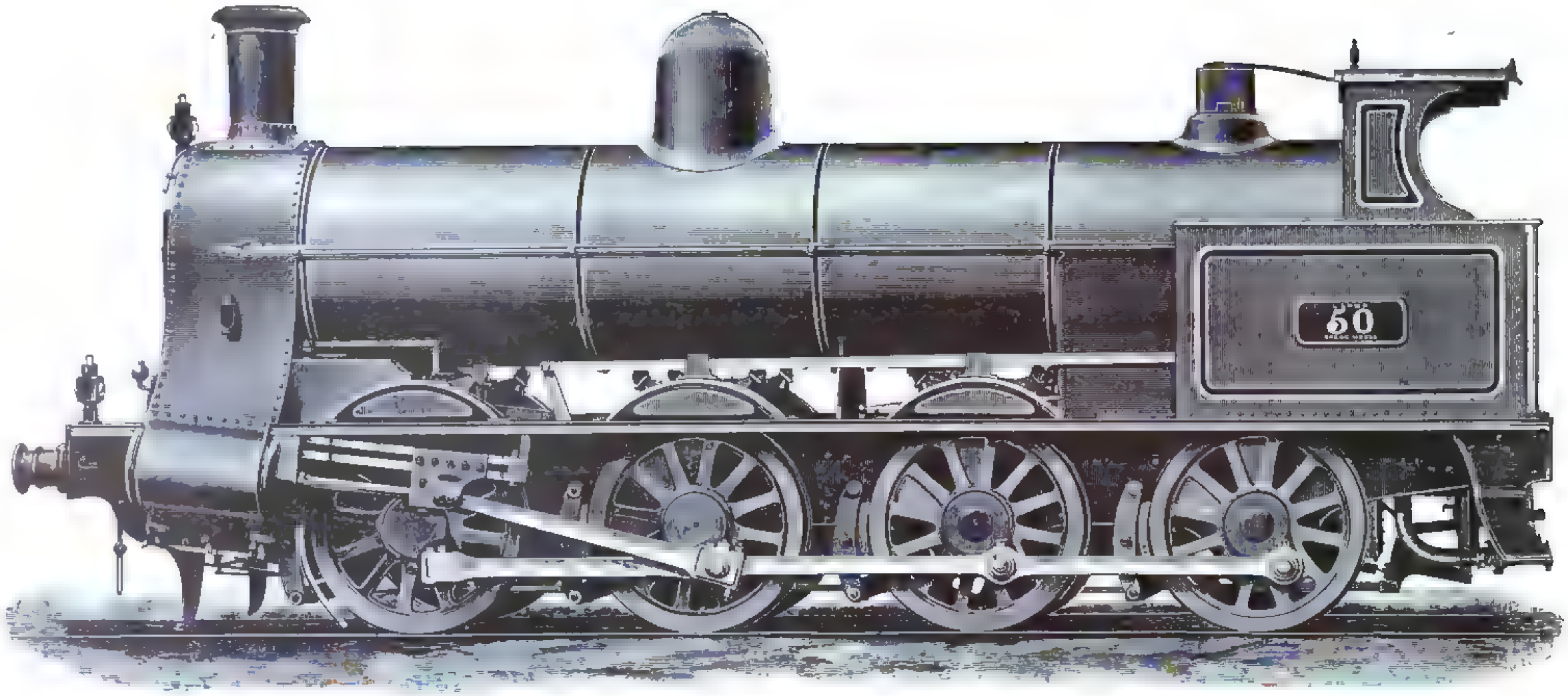
A similar car, but of somewhat different construction, is also in use at the Packerton yards of the Lehigh Valley Railroad for pushing the coal cars to their proper places after they have run over the weighing scales.

EIGHT-WHEELS COUPLED COMPOUND (WEBB'S SYSTEM) COAL ENGINE, LONDON & NORTH-WESTERN RAILWAY.

About the end of 1893 Mr. F. W. Webb, Chief Mechanical Engineer of the London & Northwestern Railway, designed and built a simple eight-coupled coal engine for heavy mineral and goods traffic, and a few months subsequently he turned out a similar engine on his compound principle, and of which we give an illustration on page 516.

It will be noticed from the illustration, and also from the particulars given below, that the boiler of the compound engine is of the ordinary type, and not of Mr. Webb's patent combustion chamber type, with which the simple engine was fitted.

All three cylinders work on to the same axle, which is built up of three pieces after the style of a marine crank shaft, the middle throw being of cast steel.



EIGHT-WHEELS COUPLED COMPOUND LOCOMOTIVE FOR THE LONDON & NORTHWESTERN RAILWAY. DESIGNED BY MR. F. W. WEBB, LOCOMOTIVE SUPERINTENDENT.

Mr. Webb decided, in order to determine the relative advantages and suitability of compound *vs.* simple engines for working mineral and ordinary goods traffic, to test these two engines as nearly as possible under identical conditions. The trials were made on April 1 last, and by the courtesy of Mr. Webb we are able to publish the following particulars of them:

Two trains were used, composed of loaded coal wagons and the necessary brake-vans, which were all carefully weighed previous to the trials. No. 1 train consisted of one dynamometer car, 52 loaded wagons and three brake-vans—total weight, 695 tons, 13 cwts. 2 qrs. 14 lbs. No. 2 train was made up in the same way, except that in the place of the dynamometer car a loaded wagon was added, equal to the weight of the car—the total weight of this train being 690 tons, 16 cwts. 1 qr. 21 lbs. These weights in both cases are exclusive of engine and tender.

In carrying out the trials, both trains were marshaled side by side on the main line opposite to the South Junction signal-box at Crewe, the engines were then attached—the compound engine to No. 1 train with the dynamometer car and the non-compound engine to No. 2 train, each engine having the same amount of fire in the box, the same height of water in the boiler and steam up to full working pressure, 160 lbs. and 175 lbs. respectively.

Both trains were started and ran side by side to Stafford, instructions having been previously given to the drivers to keep the engines level with each other. On arriving at Stafford the engines were turned and re-attached to their respective trains, which they worked back to Crewe, side by side, as before. The engines were then changed from one train to the other, and two more trips run to Stafford and back in exactly the same way as the two previous ones, so that all the conditions of working were the same for both engines. The coal used, which was "South Wales," was carefully weighed, that for "lighting up" and raising steam being kept separate from that which was used during the different trips, the latter for convenience being put into bags weighing 84 lbs. each. Every care was taken to insure the perfect accuracy of all the particulars taken during each trip, an assistant being stationed on each engine to take the steam pressures, measure the quantity of water used, and note the number of bags of coal used. Indicator diagrams were taken simultaneously on each engine at intervals going up the banks on all the trips, and the pull on the engine draw-bar and the speeds were accurately registered in the dynamometer car.

At the end of the trials only a small fire was in each of the fire-boxes, the water level in the boilers being the same as at the start.

Appended is a detail statement showing speeds, coal consumption, weight of trains, etc.:

Summary of Results.	Engine 2524. Non-compound.	Engine 50. Compound.	Economy % of the Compound.
Mean weight of train, including engine and tender	768.85 tons	767.565 tons	
" " " " excluding " " "	693.25 "	691.715 "	
Ratio of weight of engine and tender to weight of train	1 to 9.17	1 to 9.12	
Number of axles in train	120	120	
Mean speed	17.74 m. per hour	17.74 m. per hour	
Maximum speed	34 " "	34 " "	
Total length of four trips	96 miles	96 miles	
Weight of coal charged in fire-box for lighting up and raising steam	9c. 1q. 3lbs.	9c. 1q. 8lbs.	
Weight of coal consumed on trips	2t. 12c. 0q. 0lbs.	1t. 19c. 3q. 10lbs.	23.38
Total weight of coal consumed including steam raising	3t. 1c. 1q 3lbs.	2t. 9c. 0q. 13lbs.	19.84
Consumption of coal, excluding steam raising	60.66 lbs. per mile	46 48 lbs. per mile	23.38
" " " including " "	71.49 " "	57.3 " "	19.84
Total quantity of water evaporated	5,452 gallons	4,112.5 gallons	24.5
Water evaporated per lb. of coal, excluding steam raising	9.36 lbs.	9.21 lbs.	
" " " " including " "	7.94 "	7.47 "	
Total number of ton miles including weight of engine and tender	73,809 6	73,686.24	
" " " " " excluding " " " " "	66,552.0	66,404.64	
Consumption of coal per mile per ton of train, weight of engine and tender included:			
(*a*) Excluding raising of steam	1.262 oz.	.969 oz.	23.2
(*b*) Including " "	1.487 oz.	1.194 oz.	19.7
Consumption of coal per mile per ton of train, weight of engine and tender excluded:			
(*a*) Excluding raising of steam	1.4 oz.	1.075 oz.	23.2
(*b*) Including " "	1.65	1.325 oz.	19.7
Maximum pull on draw-bar at starting	10.75 tons	11.5 tons	
" " " " while running	7.25 tons	6.6 tons	
Highest indicated H.P. developed	608 6	656	
Steepest Gradient	1 in 177		

Note—The slight difference in the mean weight of the two trains was caused by several wagons in one of them having to be removed at the end of the second trip (Stafford to Crewe) owing to hot axles, and fresh wagons put in their places. On being weighed subsequently the fresh wagons were found to be rather lighter than those which had been taken off.

The most important particulars of the two engines are as follows:

	Compound Engine.	Simple Engine.
Two H.P. cylinders	15" × 24"	19½" × 24"
One L.P. cylinder	30" × 24"	
Wheels—diameter	4' 5½"	4' 5½"
Distance between centers of wheels	5' 9"	5' 9"
Total wheel base	17' 3"	17' 3"
Valve gear	H.P. link motion, L.P. Webb's	Joy's
Boiler:		
Length of barrel	15' 6"	15' 6"
Length between tube plates	13' 4"	4' 10" and 8' 1"
Mean diameter of barrel	4' 3"	4' 3"
Height of cre. line from rail	7' 10½"	7' 10½"
Number of tubes	210	156
Diameter of tubes, outside	1⅞"	2¼"
Work. press., lbs. per sq. in	175	160
Heating surface:		
Firebox	114.7 sq. ft.	114.7
Tubes	1,374.3 "	701.4 419.4
Combustion chamber	....	39.1
Total	1,489.0 sq. ft.	1,274.6
Grate area	20.5 sq. ft.	20.5 sq. ft.
Ratio of grate area to heating surface	1:72.6	1:[illegible]

Maximum weight of engine in working order:

	Compound Tons.	cwt.	qrs.	Simple Tons.	cwt.	qrs.
On the leading wheels	12	10	0	11	4	0
" " driving wheels	14	8	0	14	4	0
" " intermediate wheels	12	14	0	13	10	0
" " trailing wheels	9	13	0	10	2	0
Total	49	5	0	49	10	0

Common to both engines:

Capacity of tender	2 000 galls.
Weight of tender	26 tons, 12 cwt., 0 qrs.
Total length of engine	34' 4"
" " " " and tender	51' 9½"

—*Railway Engineer.*

THE LABOR QUESTION.

At the annual Trades Union Congress, held in Norwich, England, the following resolution with regard to technical education was adopted:

"That this Congress, while admitting that great and good work has been and is still being done by the establishment of technical classes in various localities throughout the United Kingdom, with a view of assisting in the better education of our handicraft and artisan workpeople, is of opinion that no others than apprentices and workpeople who are working at the various trades taught should be allowed to attend such classes."

It seems almost inconceivable that any body of men outside of an asylum should think that such a resolution could, at the present stage of the world's history, be enforced. It apparently means that no parent could send his son to attend a trade

school unless he is first indentured as an apprentice. The trades unions limit the number of apprentices to be taken by employers, and then say, "You shan't go to a trade school unless you are an apprentice; and we won't allow you to become one." That would be the worst kind of tyranny, and should be resisted even by fighting against it if need be.

A NATIONAL FREE LABOR ASSOCIATION.

An association with this title has been organized in England, the semi-annual report of which has recently been issued, which explains that the objects of the organization are: (1) to maintain freedom of labor; (2) to stop senseless strikes, and (3) to improve the relations between employers and employed. Hence the true aim of the association is "to protect the general body of labor from the tyranny and dictation of socialistic trade-union leaders." "For some time it has been evident," write the Executive Committee of the association, "that the methods adopted by the new trade-union leaders were effectually alienating public sympathy and creating a powerful current of adverse popular sentiment; and, encouraged by these signs, the victims of oppression have plucked up courage and are banding themselves together in their own defense. That is the meaning of the National Free Labor Association. It seeks not to break up trade unionism, but to protect workmen against the instruments by which the trade-union leaders have striven to force unionism upon men who preferred to be without it; and we know that our protest will not be offered in vain. To trade unionists the National Free Labor Association is a grave symptom. It would be serious if it were the revolt of a minority, but it becomes ominous when it is remembered that it is the revolt of a majority. Suppose, now, that free labor, being united, should wipe off old scores in trade-union coin. Suppose, for instance, non-unionists should decline to work in this factory or in that shipyard until all unionist labor had been cleared out; what would be the position of the minority then? We are far from wishing to impute unworthy motives to the men who have used against their fellows a weapon which experience has invariably proved to be double-edged. On the contrary, we are sure that the more honest labor leaders were animated by the best intentions; but they pursued a policy which was not only unjust to those who disagreed with them, but which was actually destructive to the cause they were desirous of advancing. Wishing to secure better terms for labor, they have only succeeded in driving capital into combination and free labor into a defensive and defiant organization."

The Executive Committee claim that they are able to look back with considerable satisfaction on the labor of the past six months. During that period the necessity for the existence of such an organization has again been demonstrated, perhaps more clearly than ever before, because "on five separate occasions a deliberate attempt has been made by certain sections of the labor party to crush out of existence or to starve into submission those bodies of workmen who have hitherto preferred to remain outside of the movement known as the new trade unionism." But for the existence of an organization of this kind "the views of non-union labor on each of those occasions would have been absolutely unrepresented, and the interests of the very large majority of workmen would have been sacrificed to the demands of the socialist leaders, who now claim to represent the trade-unionist workmen of this country." There are now many organized bodies of non-union workmen scattered throughout the country, such as the employés of the London & Northwestern Railway Company, of the Elswick Works, of the South Metropolitan Gas Company, and many others; but there has hitherto not been any central association or organization which represents the views and guards the interests of non-union and free labor generally, and to perform this work, so much needed, is the sole aim of the executive of the association. The committee are of opinion that "the conflict between capital and labor has by no means reached its climax yet, for recent troubles in America point to developments in strike warfare which this country has fortunately not attained to; but if masters will only act unitedly, and stand by one another, as the federated trade unions are now doing, and, above all, if they will support and protect from injury those of their employés who are totally at variance with the present policy of the new trade unionism, we feel certain that the party which depends for its forces upon intimidation, class hatred, and violence will receive a complete overthrow, for the great bulk of the working classes are completely sick of the meddlesomeness and tyranny which characterize the trade-union officials of the present day."

The report finally refers to the action taken by the executive to resist the proposal of the London Trades Council that the Metropolitan Asylums Board should insert in every building contract given out by them a clause preventing the employment of non-union workmen. After hearing a deputation from the association, the Board, by a majority of 12, rejected the trade-union suggestion. "This, again," the committee state, "is a striking instance of the impertinent proposals now emanating from the trade-union leaders, and of the need to be constantly on the watch, lest on such occasions the interests of non-unionists should be entirely overlooked. It also proves that free labor has generally the best of the argument when the matters in dispute are arbitrated upon by a fearless and impartial tribunal."

SUCCESSFUL CONCILIATION.

A remarkable agreement has just been effected between the Tyne, Wear, Tees and Hartlepool ship-builders and the executive council of the Boiler-makers' and Iron and Steel Ship-builders' Society, one of the most important trade unions in Great Britain. In respect to wages, it sets forth that no general alteration shall be made until after 6 calendar months have elapsed from the date of the last alteration, and no single alteration can exceed 5 per cent. Four weeks' notice in writing is to be given. Previous to such notice being given by either side, a request for a meeting between the associated employers and the Boiler-makers' Society must be given by the party intending to give notice; this meeting to be held within 14 days after the receipt of the request. Failing agreement during the month's notice, the notice may be extended to any time not exceeding another month, if acceptable to both parties; but, whatever the settlement may be, the advance or reduction (if any) will begin from the expiration of the first month's notice. Should a settlement not be effected, the question may be dealt with as may seem best. Sectional or individual disputes, in the first instance, are to be referred to the society's officials and the employer or his representatives. If any dispute takes place respecting the price of work, the job is to be proceeded with as on piece, and, whatever the price may be when the dispute is settled, the same will be paid from the beginning of the job. Failing a settlement by ordinary means, the terms of settlement are to be adjusted by a committee representing employers and the Boiler-makers' and Iron and Steel Ship-builders' Society within 14 days. Power is also given to each side to ask for a revision of rates in certain contingencies, and it is stipulated that work in all cases shall be proceeded with without interruption pending the settlement of a dispute, whether as to prices or otherwise. A standing committee of three on each side (exclusive of the delegate on each side) is to be appointed for each river to consider local disputes. The scheme is to be tried for a period of 5 years, to be afterward terminable by 6 months' notice on either side. The result of the voting by the men upon these proposals was as follows: For, 15,950; against, 11,840; majority for, 4,110.

ARBITRATION, COMPULSORY AND VOLUNTARY.

Some time ago the editor of the New York *Sun* asked the Indianapolis *Sentinel* how it would like to be forced to arbitrate, and forced to accept the result, supposing that its employés should ask to have their wages raised when it was making no money or actually losing money; and the *Sentinel* replied by giving this form of contract which it makes with its typographical union:

"Any and all disputes or disagreements that cannot be settled by the parties directly concerned shall be referred to an arbitration committee made up as follows: One member to be chosen by the *Sentinel* Company, one by the Indianapolis Typographical Union No. 1. If these two thus chosen agree, their decision shall be final; if they are unable to agree, then they shall select a third person to act with them in hearing and determining the matter at issue. The decision of a majority of the committee thus constituted shall be final and binding upon all the parties hereto. Pending the deliberations of the committee in the settlement of differences as herein provided there shall be no strike or lockout in the *Sentinel* office."

To this the *Sun* replied:

"The *Sentinel's* plan is not compulsory arbitration, but arbitration by consent of both parties. We are glad to believe that this arrangement has worked well in the *Sentinel* office. At any moment, however, there may come so radical a difference between the views of the two parties, or so one-sided a decision by the arbitrators, that the plan will break down. Nor is a one-sided decision necessary to produce that result. A compromising decision may make the parties just as hot. Persons convinced of the absolute right of their claim are not necessarily reconciled to getting one-half of it. . . . Suppose there was a system of true compulsory arbitration, that there were courts of arbitration able to enforce their decisions as United States courts now are. How long would employers or workmen put up with a system that put the regulation of wages and profits and losses into the hands of third persons? How long could business stand such a system? But, of course,

there can be no such thing under our present form of government. As a matter of fact, mighty few persons want such a system."

The editor of the *Sun* also asks, very pertinently, how an unsatisfactory decision, either against the employers or the men, is to be enforced. Still it is not apparent why arbitration should not be resorted to in cases in which it will work because there are some other imaginary conditions in which it would not work.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.

SECOND SERIES.—CHEMICAL METHODS.

XI.—METHOD OF DETERMINING IRON IN COMMERCIAL SPELTER.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(*Continued from page 453.*)

OPERATION.

Put 10 grams of coarse borings or chips in a beaker holding about 300 c.c , and 100 c.c. of dilute sulphuric acid. Cover with a watch glass and allow to dissolve. When solution is complete add 100 c.c. of distilled water, and then pass through the Jones reductor, or its equivalent, and add through the reductor about 200 c.c. more of distilled water. Then titrate in the reductor flask with standard permanganate of potash.

APPARATUS AND REAGENTS.

The reductor shown in fig. 1 seems to work equally as well as the more elaborate apparatus. The cut is about one-fourth the actual size. As will be seen, the glass tube is fitted with two rubber stoppers, the top one of which holds the funnel, and the bottom one a small tube, which tube also fits tightly into the rubber stopper in the flask. Next to the bottom stopper is a disk of perforated platinum; then a layer of about ¼ in. thick of glass wool; then a layer of asbestos about ¼ in. thick; then a layer of glass wool about ½ in. thick, and then the tube is nearly filled with powdered zinc. The glass wool may be obtained from Bullock & Crenshaw, 528 Arch Street, Philadelphia, Pa. The powdered zinc used is that which will pass through a 20-mesh sieve, and will not pass through a 30 mesh sieve. It may be obtained from Baker & Adamson, Easton, Pa.

The dilute sulphuric acid is made by adding 20 c.c. of C. P. sulphuric acid 1.84 specific gravity to 80 c.c. of distilled water.

The permanganate of potash solution for titration is made as follows: To one liter of water add two grams of crystallized permanganate of potash, and allow to stand in the dark not less than a week before using. Determine the value of this solution in terms of metallic iron. For this purpose 150 to 200 milligrams of iron wire of mild steel are dissolved in dilute sulphuric acid [10 c.c. of strong C. P. acid to 40 c.c. of water] in a long-necked flask. After solution is complete, boil 5 to 10 minutes, then dilute to 150 c.c., pass the liquid through the reductor and wash, making the volume up to 200 c.c. Now titrate with the permanganate solution. It is of course essential that the amount of iron in the wire or soft steel should be known. The standard in use in the Pennsylvania Railroad laboratory is a mild steel in which the iron is known by determining carbon, phosphorus, silicon, sulphur, manganese and copper, and deducting the sum of these from 100 per cent. Not less than two independent determinations should be made, and three are better. The figures showing the value of the permanganate solution in terms of metallic iron should agree to a hundredth of a milligram in the different determinations. A very satisfactory method of making and keeping permanganate of potash solution is as follows: Have a large glass bottle holding say eight liters, and two of half the size. Paint the outside of these bottles with several coats of black varnish or paint. Fill the large bottle with the standard solution, and after it has stood a proper time fill one of the smaller bottles from it without shaking, and standardize. At the same time fill the second small bottle and refill the large one. When the first small bottle is exhausted standardize the second one and fill the first from the stock. When this is exhausted standardize the first again and fill the second from stock, refilling again the stock bottle, and so on. By this means a constant supply of sufficiently matured permanganate is always available. Of course, if the consumption is very large, larger bottles or more of them may be required. Since changes of temperature affect the volume of all solutions, it is desirable that the permanganate solution should be used at the same temperature at which it was standardized.

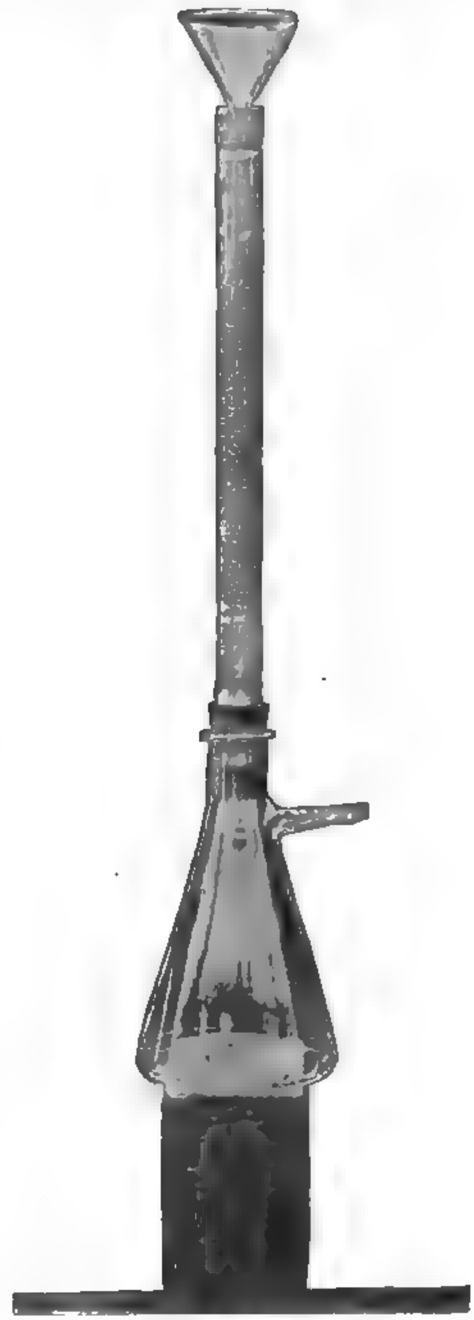


Fig. 1.

CALCULATIONS.

The soft steel used in standardizing permanganate of potash solution in the Pennsylvania Railroad laboratory contains 99.27 per cent. metallic iron; .1498 gram of this contains, therefore [.1498 × 9927] .1487064 gram of metallic iron. This requires 42.9 c.c. permanganate solution, or one c.c. of permanganate solution is equal to [.1487064 ÷ 42.9] .003466 metallic iron. The number of c.c. of permanganate used multiplied by this figure shows the amount of metallic iron in 10 grams of the zinc, and 100 grams or the percentage will be 10 times this

LOCOMOTIVE RETURNS FOR THE MONTH OF JULY, 1894.

			Locomotive Mileage.					Av. Train.		Coal Burned per Mile.						Cost per Locomotive Mile.							Cost per Car Mile.		
Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Passenger Trains.	Freight Trains.	Service and Switching.*	Total.	Average per Engine.	Passenger Cars.	Freight Cars.	Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Passenger.	Freight.	Cost of Coal per Ton.
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Atchison, Topeka & Santa Fé	864	787			360,747	1,818,440	2,059						75.47			2.81	7.66	0.19	0.18	5.74	1.64	19.22			1.94
Canadian Pacific	606		508,236	517,281	456,774	1,482,291	2,446						60.69			2.54	9.11	0.29		5.67	1.19	18.80		1.76	3.82
Chic., Burlington & Quincy	541					1,346,050	2,488	5.28	19.09				78.12			4.01	6.28	0.16	0.12	6.80	0.08	17.40			1.60
Chic., Milwaukee & St. Paul	855					1,774,067	2,075						55.05			2.96	7.39	0.25		6.90		17.50			2.77
Chic., Rock Island & Pacific	564		417,410	531,105	278,399	1,226,914	2,001						56.19	10.18	4.04	4.02	5.61	0.31		6.26	0.41	16.50			2.06
Chicago & Northwestern			803,465	1,081,769	498,339	2,383,573							68.05			1.97	8.31	0.28		6.83	0.92	17.80			
Cincinnati Southern																									
Cumberland & Penn.*	23		5,571	33,762		39,333	1,700						79.66			4.14	4.30	0.36			1.66	10.46			
Delaware, Lackawanna & W. Main L	213	193	70,820	193,285	380,220	644,327	3,350						79.77			2.94	6.04	0.42		5.82		15.22			1.50
Morris & Essex Division	162		181,593	136,317	92,463	410,383	2,533						62.33			3.83	9.86	0.40		7.17		21.26			3.08
Flint & Père Marquette			92,120	63,350	49,156	204,626				48.91	74.66	39.22	55.95			2.764	5.608	0.116	0.015	5.079	0.964	14.546			1.90
Hannibal & St. Joseph	74		651,861	155,681	33,511	841,056	11,366	5.68	16.24				75.09			2.27	6.07	0.11	0.30	6.71		15.46			
Kansas City, Ft. S. & Memphis	134		79,928	155,855	70,367	306,150	2,284						61.51			1.95	3.98	0.33	0.42	7.52		14.19			1.25
Kan. City, Mem. & Birm																									
Kan. City, St. Jo. & Council Bluffs	36		51,893	39,660	41,368	132,921	3,692			12 93	439		63.58			3.23	7.31	0.18	0.69	6.96		18.81			2.25
Lake Shore & Mich Southern	595		378,014	623,218	366,002	1,367,234	2,294						60.04			2.40	6.83	0.12		7.05	0.16	16.60			2.27
Louisville & Nashville																									
Manhattan Elevated	280		709,123		63,077	772,200	2,758						34.74			2.00	7.0	0.20	0.50	9.4		19.1			4.06
Mexican Central																									
Minn., St. Paul & Sault Ste. Marie	104	75	89,875	82,356	25,545	197,776	1,901						50.62			1.72	6.54		0.23	6.53		15.02	2.84	1.03	2.54
Missouri Pacific	351		6,002,683	6,819,270		1,379,492	3,030	4.41	16.88				73.50			3.04	5.63	0.30	1.17	6.47	1.24	17.35	3.54	1.25	1.50
Mobile & Ohio	105	74	51,729	116,191	49,925	217,845	2,941						59.79			1.12	4.31	0.21	1.83	5.57		18.04			1.48
N. O. and Northeastern																									
N. Y., Lake Erie & Western	625		445,945	692,244	241,927	1,380,116	2,208	4.70	24.00	91.60	134.80	78.05	101.48	19.50	5.00	4.30	7.97	0.35	1.80	7.41	1.30	23.13		1.71	1.46
N. Y., N. H. & H., Old Colony Div			552,798	196,525	186,483	935,806							62.83			2.66	9.44	0.49		7.00	0.69	20.28			
N. Y., Pennsylvania & Ohio	278		129,343	295,907	119,559	544,810	1,959	5.70	19.10	70.60	125.10	67.60	59.55	12.30	5.40	2.05	5.75	0.30	2.46	7.16	1.18	18.90		1.61	1.30
Norfolk & Western, Gen. East. Div.†			83,963	310,769	50,819	445,524	2,700	5.26	20.68	45.37	122.67		82.02	8.62	5.93	5.68	3.22	0.27				9.17			
General Western Division†			107,048	362,001	58,369	527,418	2,635	5.13	16.27	70.00	124.00		115.00	13.59	7.60	10.38	3.74	0.23				14.35			
Ohio and Mississippi																									
Philadelphia & Reading			459,085	282,907	927,965	1,720,008							77.39			04.05	4.29	0.20		5.66	.44	14.64			
Southern Pacific, Pacific System	723	616	440,154	507,471	165,578	1,113,203	1,807	4.99	18.42				63.65			2.75	16.21	0.20	2.29	7.57	1.28	30.30			4.80
Union Pacific	796	908	355,551	581,254	236,322	1,173,127	2,885	5.88	18.42				88.34			7.01	8.04	0.35		8.21	1.18	24.79	4.12	1.75	1.81
Wabash	418	330	367,162	399,078	133,637	899,877	2,726	4.49	17.07		19.37	33.66	81.52			3.21	5.28	0.34		5.85	1.11	15.79	3.16	1.06	1.30
Wisconsin Central	149	106	145,452	111,578	73,746	308,587	2,911						58.24			2.88	3.34	0.17		6.92		18.31			2.84

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars. Empty cars which are reckoned as one loaded car are not given upon all of the official reports, from which the above table is compiled. The Union and Southern Pacific, and New York, New Haven & Hartford rate two empties as one loaded; the Kansas City, St. Joseph & Council Bluffs, and Hannibal & St. Joseph Railroads rate three empties as two loaded; and the Missouri Pacific and the Wabash Railroads rate five empties as three loaded, so the average may be taken as practically two empties to one loaded

* Switching engines allowed 6 miles per hour; wood, construction and gravel trains, 10 miles per hour.

† Wages of engineers and firemen not included in cost.

amount. This may be briefly stated as follows: Multiply the number of c.c. of permanganate used by the value of one c.c. of the permanganate expressed in grams of metallic iron, and then move the decimal point of the product one place to the right. The result will be the percentage of metallic iron in the zinc. Thus, if one c.c. of the permanganate is equal to 0.003466 gram of metallic iron, and 2.4 c.c. are used, the percentage of iron in the zinc will be [0.03466 × 2.4 = .00831] 0.0831 per cent.

NOTES AND PRECAUTIONS.

It will be observed that this method dissolves the iron along with the zinc in sulphuric acid, makes sure that the iron is all in the protoxide form, and frees the solution from possible impurities by passing it through the reductor, and then measures the amount of iron by means of standard permanganate of potash.

It may be thought that since the iron goes into solution in presence of such a large amount of metallic zinc, it is not essential to pass the liquid through the reductor. But careful comparative tests indicate that even though the zinc is dissolved in a flask, with every precaution to exclude the air, the same results are not obtained if the reductor is not used. This is apparently due to metallic lead and possible traces of carbon, which the reductor removes, and which, if the reductor is not used, remain in the solution and use up a little permanganate. Filtration without the use of the reductor is believed not to be as satisfactory, on account of danger of oxidation of some of the iron by exposure to the air.

The description and measurements given along with the cut will perhaps enable any one to make a suitable reductor for themselves. If a tube about 1 in. in diameter is used, and the powdered zinc does not reach to within 3 or 4 in. of the top, the funnel and its cork may be left off, the liquid being poured into the tube direct from the beaker. In this case the bubbling difficulty mentioned below does not occur. Of course the tube above the zinc not be filled so full of liquid that the disengaged hydrogen bubbles will throw any of it out. The layer of asbestos serves as a filter and removes from the liquid, as before mentioned, material that uses up permanganate. After the reductor has been used a little a black line at the top of the layer of asbestos shows this material quite plainly. A reductor made of glass wool alone without a filter in it below the zinc, is apt to give erratic and discordant results. There is considerable evidence that without the filter minute fragments of zinc, so small as to escape ready detection, pass through the reductor, of course producing error in the subsequent titrations. If the layer of asbestos is too thick or is packed too hard the flow may be too greatly retarded. A hard-packed layer of asbestos ¼ in. thick makes a reductor almost unusable even with quite strong suction. It is essential before using the reductor to pass two or three blanks through, containing all the materials except the substance being analyzed, and then titrate these blanks. The last two blanks should agree exactly, and the amount of permanganate used up by the last blank should be deducted from the final figure obtained on titration of the substance being analyzed. This preliminary preparation of the reductor is essential after a new charging with powdered zinc, and also equally essential after the reductor has stood idle even over night. The rate at which the material passes through the reductor can be controlled somewhat by the suction. The apparatus is very efficient, and there seems little danger of too rapid a rate, but it is of course essential that the reduction should be complete. In case of incomplete reduction pass the liquid through the reductor again. If the rate is somewhat slow and the solution being reduced somewhat warm, hydrogen gas enough may be generated to throw some of the liquid up against the sides of the tube above the zinc, and also bubble up through the liquid in the funnel. Care should be taken that this latter does not result in loss, and that the liquid adhering to the sides of the tube is removed by the subsequent washing.

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

The object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publications will in time indicate some of the causes of accidents of this kind, and to help lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with the information which will help make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a great favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in September, has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS IN SEPTEMBER.

Philadelphia, Pa., September 1.—A freight train on the Philadelphia, Wilmington & Baltimore Railroad struck a coal wagon at the corner of Twenty third and Chestnut streets this morning. The train was wrecked and the fireman and the engineer were badly injured.

Halifax, N. S., September 1.—The oldest locomotive driver in Canada was crushed to death at Westville to-day by the wheels of his locomotive.

Pine City, Mich., September 2.—A train filled with fugitives from Hinckley was burned near here to-day. Engineer Root remained on the engine, assisted by his fireman, who kept him soaked with water, and backed the train away from Hinckley and to a point where the refugees were enabled to escape. Both engineer and fireman are severely burned.

Jersey City, N. J., September 2.—Thomas Fagan, an engineer on the Lehigh Valley Railroad, while switching cars on a car float this morning, was frightened by the gang chain, carrying one side of the bridge, giving way; he jumped from the locomotive, striking the bridge and receiving serious internal injuries.

Grand Rapids, Mich., September 2.—A Chicago & West Michigan passenger train ran into a herd of cattle north of here to-day. The fireman, John Kabe, was killed by being crushed under the engine.

Marquette, Mich., September 3.—A train on the Milwaukee Northern was wrecked near here to-day. Engineer Fred Almquist was killed. The wreck was caused by forest fires burning the ties and warping the rails.

Columbus, O., September 4.—A runaway train, consisting of eight loaded coal cars on the Big Four Railroad, ran into and collided with a Baltimore & Ohio passenger train at Ottantangy River bridge to-day. It is reported that a fireman was killed. Engineer Smallwood was severely injured.

Utica, N. Y., September 4.—The bursting of a water gauge on the Rome, Watertown & Ogdensburg Railroad severely scalded the engineer, L. C. Allen, on the right side of the face and neck.

Wilkesbarre, Pa., September 6.—The connecting-rod on a locomotive, on the Lehigh Valley Railroad, of a fast freight train broke here to-day. Wallace Reed, the fireman, jumped from the train, sustaining internal injuries, which will probably prove fatal.

Arcadia, Wis., September 6.—A freight train on the Green Bay, Winona & St. Paul Railroad ran into a burning bridge north of here to-day; the bridge gave way, and the engine with 18 cars was wrecked. The engineer and fireman jumped, but were slightly injured.

Bakersfield, Cal., September 7.—A collision occurred between a passenger and freight train on the Southern Pacific Railroad at this point this morning. One of the firemen had two ribs broken, and the other was bruised.

Staunton, Ill., September 7.—A freight train broke in two at this point to-day while on a side track, part of it running on to the main line; this was run into by a fast mail train on the Wabash Railroad. Engineer Flanning was severely scalded and had his legs broken. C. A. Samms, fireman, had his foot broken and was scalded.

Bound Brook, N. J., September 8.—During a dense fog this morning there was a rear-end collision of a freight train on the Central Railroad of New Jersey at this place. The engineer, Thomas A. McQueen, was seriously injured, if not fatally so.

Raton, N. M., September 8.—An express train on the Atchison, Topeka & Santa Fé Railroad was ditched at Dillon Junction this afternoon. Engineer Pat Doyle was cut about the head and bruised in the hip and shoulder. The fireman, Joe Meaden, was slightly bruised about the head and body.

Lock Haven, Pa., September 8.—There was a collision between a freight and work train on the Philadelphia & Reading Railroad near here to-day. Engineer and fireman were killed.

Barrington, Ill., September 9.—A passenger train on the Chicago & Northwestern Railroad ran into a coal car at this point to-night. Engineer Stearns was injured, but not seriously. Fireman McMann, however, was instantly killed.

Clinton, Ill., September 8.—A wreck occurred on the Terre Haute & Peoria Branch of the Vandalia Line, in which Engineer J. Williams was instantly killed. Cause of the wreck was cattle on the track.

North Adams, Mass., September 9.—There was a rear-end collision between two freight trains in the Hoosac Tunnel to-night, in which Charles C. Clapp, engineer, and Charles Fraser were seriously injured; Clapp being bruised about the body, with internal injuries, and Fraser was scalded and suffered a fracture of the pelvis; his hands were badly scalded by escaping steam; it is thought also that his skull is fractured; it is probable that he will not recover.

Fairbury, Ill., September 9.—A mail train on the Wabash Railroad was ditched near America this afternoon. A. C. Miller, engineer, was killed, and a fireman named Gilman received injuries from which he cannot recover.

New Orleans, La., September 9.—An excursion train on the New Orleans & Southern Railroad jumped the track at Florissaint Plantation to-night for some reason. The engineer, David Crawford, was fatally crushed.

Chillicothe, Mo., September 10.—A cattle train on the Hannibal & St. Paul Railroad ran into a bull lying on the track near here to-night. Engineer Frank Worts was fatally injured; he was under his engine an hour before he was extricated.

Baltimore, Md., September 11.—A collision occurred between the express train and yard engine on the Northern Central Railroad at this point to-day. Engineer Reed and Fireman Rice, on the passenger train, were hurt, but not seriously.

Cambridgeport, Mass., September 12.—A collision took place between two contractors' engines at this point to-day, in which one engineer got entangled in the wreck and had his legs jammed; the other engineer was cut about the cheek.

Boston, Mass., September 12.—An engine on the Old Colony Railroad ran through an open drawbridge near the Kneeland Street Station to day. The engineer and fireman jumped and escaped with slight injuries.

Duluth, Minn., September 14.—An ore train on the Duluth, Missabe & Northern Railroad struck an ox this side of Virginia this morning. The fireman, John Murphy, was slightly injured.

Bessemer, Mich., September 18.—Engineer John Kafer was instantly killed, and his fireman, Paul Scheffer, fatally injured by the complete upsetting of a switch engine in the Wisconsin Central Railway yard. The accident was caused by running over a cow.

Gorin, Mo., September 18.—An attempt was made by robbers to hold up a train on the Atchison, Topeka & Santa Fé Railroad near here to-day. The robbers were repulsed, but not before they had wounded Engineer Prescott in the shoulder.

Moberly, Mo., September 18.—An engine hauling an express train on the Wabash Railroad became unmanageable near here to-day and ran away for a considerable distance until it was derailed. Frank Kerlser, the fireman, was thrown from the cab and fatally hurt.

Redwood, Cal., September 18.—A passenger train on the Southern Pacific Railroad ran into a freight train at Belmont this morning. The engineer of the passenger train was badly hurt.

Knoxville, Tenn., September 18.—Thomas W. Carter, an engineer on the Knoxville, Cumberland Gap & Louisville Road, fell off an engine and was instantly killed to-day near Lonesome Valley.

Philadelphia, Pa., September 18.—James Boyle, an engineer on the North Pennsylvania Railroad, was thrown from his engine to-day, receiving severe injuries about the head and legs.

Harrington, Del., September 20.—The crown sheet of an engine on the Delaware Railroad blew out here to-day. Engineer John Parsons and Fireman Albert C. Dunn were scalded by escaping steam; Parsons also had his left side scalded.

Fraserville, Ont., September 22.—A Grand Trunk freight train was wrecked near here this morning. The engineer and fireman were killed. Caused by a cow being on the track.

Buffalo, N. Y., September 22.—A collision occurred between a freight train and a derailed car two miles west of this city this morning. Fireman Lampkin was considerably bruised about the head and shoulders.

Mason City, Ia., September 22.—A collision occurred between a freight train and a runaway box car that had been blown on a main line from a side track on the Chicago, Milwaukee & St. Paul Railroad near Algona; the fireman, Charles McAldoon, was seriously injured, and Engineer Humphrey was slightly injured.

Indianapolis, Ind., September 22.—Charles Howard, a fireman on the St. Louis Division of the Big Four Railroad, fell asleep on the track near here to-day; he was struck by a passing train and killed.

Sacramento, Cal., September 23.—The boiler head on a locomotive of a freight train on the Union Pacific Railroad blew out while passing through the snow sheds to-day. Engineer Warren Goodard was injured, and Fireman Charles Lipscom hurt so that he died a few hours after the accident.

Albany, N. Y., September 24.—C. Addison Edwards, an engineer on the New York Central & Hudson River Railroad, while examining the eccentrics of his engine, was run over by his locomotive, being struck by the switching engine. His arm was so badly crushed that it had to be amputated.

Wilmington, Del., September 27.—John Shields, a fireman on the Philadelphia, Wilmington & Delaware Railroad, had his hand severely cut, by thrusting it through the window of the cab.

Hoboken, N. J., September 28.—Fred Wyman, a fireman on the Delaware, Lackawanna & Western Railroad, had his legs cut off and was otherwise badly injured by an engine; he jumped from one engine in front of another and was caught.

Boston, Mass., September 28.—A connecting-rod on a locomotive hauling an express train on the New York, New Haven & Hartford Railroad broke this morning. Dennis Conklin, the fireman, was injured by a flying bolt.

Portland, Ore., September 28.—An engine on the Northern Pacific train backed off a ferry boat at Kalama to-day. Peter Cramer, the fireman, was carried over with the engine and drowned.

Anderson, Ind., September 29.—A woman signaled a north-bound freight train of the Michigan Division of the Big Four Railroad, warning them of danger on the track to-day. The engineer, Crowley, in reversing his engine was severely injured. In throwing the reverse engine back it slipped, and flying forward struck him a violent blow in the side, breaking three ribs and fracturing two others.

Our report for September, it will be seen, includes 43 accidents, in which 9 engineers and 11 firemen were killed, and 25 engineers and 19 firemen were injured. The causes of the accidents may be classified as follows:

Boiler explosions	2
Broken connecting-rod	2
Burned bridge	1
Bursting water-glass	1
Cattle on track	7
Collisions	8
Cut in cab window	1
Derailments	3
Falling from engine	2
Flying reverse lever	1
Forest fires	2
Jumping from engine	1
Obstruction on track	1
Open draw bridge	1
Runaway train	4
Running off float	1
Run over	4
Train robbers	1
Total	43

PROCEEDINGS OF SOCIETIES.

Engineers' Club of St. Louis.—The regular meeting was held on September 19, at which Mr. E. A. Hermann read a paper on Reconstruction and Improvement Work on Railroads. The paper was a general *résumé* of work that must necessarily be done in reconstruction where the original was done cheaply or poorly executed. He calls attention to the fact that the improvement in rolling stock was usually in advance of that in the roadway, and that the weight of locomotives and cars increase in a much more rapid ratio than the strength of track and bridges.

The Engineers' Club of St. Louis.—At a meeting on October 3, Mr. N. W. Eayres gave an informal talk on the power house of the new Union Station steam plant. It consists of four 250-H.P. water tube boilers set with revolving chain grates; the latter cost $1,000 per boiler, and have proved entirely satisfactory, particularly in abating the smoke. Three compound engines and two air compressors are used; the engines are directly connected with the dynamos, which operate at 500 volts, whose output is distributed by the five-wire system, permitting the operation of arc and incandescent lamps; the compressors furnish air for the interlocking. The plant is the largest in the country, and 240 train movements were recently made in a single hour. The station is heated by steam from this plant, the indirect system being used. Air is taken in at the top of the tower by two fans in the subcellar,

and pass over steam coils; each fan is driven by a 40-H.P. motor; direct radiation, however, is used in the offices.

Central Railway Club.—At the September meeting of the Club, Mr. R. H. Soule and Robert Potts presented a report on car cleaning, from which we make the following extract:

"Cars on long runs, of say 200 miles or over, on arrival at terminal stations in summer or non-freezing weather should be thoroughly washed off on the outside with clear, cold water. For such washing an arrangement consisting of a hollow handle attached to a perforated brush head, through which a stream of water is applied simultaneous with the rubbing of brush, for use where hose connections are available, has been recommended to the committee as superior to the common car wash brush generally used. Where bucket and brush is used care should be taken to renew the water before it becomes gritty through successive dippings of the brush. The hand rails and door knobs should be wiped clean, the other parts of car body being not wiped, but merely washed thoroughly as above. The trucks should also be wiped on the outside, and other parts that can be reached without going under the trucks. In freezing weather the cars should be cleaned on the outside by dry wiping exclusively. No injury to varnish will occur under this process, and a better appearance will be attained than by the use of warm water. In addition to the ordinary wishings at end of trips, the practice on one road is to give to the cars at intervals of three months each, between soppings, a thorough cleaning with Perfection Car Cleaner diluted with water, according to condition of car. This compound, however, is absolutely non-injurious to varnish, whether used in full strength or diluted, and may be applied by unskilled labor with perfect safety and with most gratifying results. The cleaner is applied with an ordinary car wash brush, and if the corners of the battens or bottoms of panels are especially dirty, a two or four-row car scrub is used. Cars cleaned under this process come out almost as good as new on the outside, leaving the gloss on the varnish unimpaired. On the arrival of a car the first duty is the care of the lamps, if it is so equipped. Lamps should be cleaned and wicks and oil applied, the latter of 300 fire test. If the car is equipped with gas, the globes should not be cleaned until all the other work on the inside of the car is done. Water coolers should be emptied, rinsed and wiped out inside. Closets, urinals, and drip pans should be thoroughly washed out and rinsed, followed by another rinsing with a solution composed of chloro-naphtholeum and water in proportions of 1 gall. of naphtholeum to 1 bbl. of water. Urinals thus treated will remain odorless during continuous trips between terminals, and icings of the urinals will not be necessary. Next, the cushions should be taken out, doors and windows opened, and the interior of car dusted throughout. The wood-work and glass should then be wiped, and if necessary cleaned off with a damp sponge. The floor should be mopped with cold water in summer and warm water in winter, and sponged under the seats, corners of car, and under the steam pipes with soft soap or kindred compounds, and rinsed with cold water. The cushions should be thoroughly dusted and put back in place, and windows, doors, and ventilators closed to prevent dust blowing in from the outside. Curtains or blinds should also be drawn to preserve the color of the upholstery. Upholstery should be beaten or cleaned by the use of compressed air once a week during the summer months, and twice a month at least during the winter."

At the same meeting Mr. West, of the New York, Ontario & Western Railroad, presented a report on the best construction and practice for locomotive driving-boxes; he stated that, in the opinion of the committee, the solid bronze box is not to be recommended for general use, but that there was a difference of opinion as to the relative merits of cast steel as compared with cast iron, and solid brass lining as compared with the gib brass in connection with soft-metal fillings. The reasons for not recommending the use of a solid bronze box are the greater first cost, undue expansion when hot, causing the box to stick in the jaw of the frame; and when the box becomes worn in the crown, the sides are very apt to close in, pinching the journal and causing a hot box. The argument presented in favor of solid bronze bearing, was that the first cost is less than the brass gib with the soft filling; while if the journal gets hot there is no soft metal to melt and plug up the oil holes. The box with brass gibs also is more liable to break on account of cracks starting from the corner of the slots that are cut for the brass. The advantage of the solid bronze crown, pressed into the cast-iron box with two strips of soft metal 1 in. wide, extending to the full width of the box, is that the bearing will probably run cooler on account of the soft metal. A sectional bearing composed of a bronze gib with soft-metal filling has the advantage that there would be no hot boxes to melt the filling. The practice of planing the flanges straight at the center for a distance of 2½ in., and tapering from there to the top and bottom, thus allowing the box to adjust itself, when one wheel strikes the low joint, thus preventing the breaking of the flanges, was heartily indorsed.

PERSONALS.

Mr. Willard A. Smith has been appointed Harrier Curator of the transportation division of the Department of Industrial Arts of the Columbian Museum of Chicago.

Mr. Ernest S. Cronise announces that he has severed his connection with Henry P. Worthington, and is engaging in business on his own account, as direct representative of leading houses, as a commission dealer in iron, steel, railway equipments and supplies, giving particular attention to the export trade, with an office at 37 Broad Street, New York.

Mr. Winfield Price Pressenger, of the Clayton Air Compressor Works, of New York, has just returned from Europe, where he has been spending his vacation in studying air compressor practice in the Old World. While in Paris he made a careful examination of the compressed air power system in use in that city, of which Mr. Victor Popp is the President.

Manufactures.

THE IMPROVED ROOT BOILER.

As the subject of water-tube boilers is attracting a constantly widening interest on account of the saving in fuel which they effect, we illustrate an improved form of this type of boiler made by the Abenroth & Root Manufacturing Company, of 28 Cliff Street, New York. The illustrations show very clearly the method used in its construction, to which but a few words of reference will be necessary.

DETAILS OF BOILER.

Two parallel boiler tubes 4 in. in diameter are expanded into a header at each end (fig. 1), forming what is known as a package. These packages are then piled one upon the other, as shown in fig. 2, and on top of this pile is placed a steam and water drum, all forming a vertical section. A side view of this arrangement is shown in fig. 7. The openings at the front and rear ends of these box-like headers are connected by means of connecting bends, as shown in detail in fig. 3. These, in turn, have plug-shaped ends (fig. 5), which are drawn tightly into elastic, bronze-like metal packing rings (fig. 4) seated in the headers (fig. 6), this being done by means of two bolts, thus forming a joint, which can easily be made up and kept tight.

The bolts holding the bends in place have ball-shaped heads, which are received in spherical sockets in the headers, thus giving the nut end of the bolt perfect freedom of motion.

After connecting the headers front and rear in the manner above described, it will be seen, by referring to fig. 7, that, as the water inside the inclined tubes is heated, it will rise in them to the headers, and then it will flow upward from one boxlike header through the connecting bend into the one above it, and so on to the top, and thence into the overhead drum

(at the front end). This overhead drum is about half full of water.

By constructing the vertical section in the manner described it is made flexible, and can readily adjust itself to the unequal expansion of the tubes without placing excessive strains on the various parts. In making up a boiler, a number of these vertical sections are placed side by side, the height and width of the arrangement of tubes being governed first by the amount of heating surface required, and secondly by the space available in which the boiler is set.

The method of construction at the rear ends of the boiler is shown in fig. 8, where four boilers are seen. Over the top of the several steam and water drums is shown the multiple which collects the steam from each and finally delivers it into the steam drum. About the center, beneath the steam and water drums, is shown the feed drum, below which is seen the mud drum. When the complete boiler is constructed the headers are arranged similar to bricks in a wall—*i.e.*, with their vertical joints broken; and as a brick can easily be removed from the lower part of a wall and replaced without disturbing those around it, similarly a package of tubes can easily be removed and replaced in the boiler when the fittings at the end of the package are taken off. This arrangement also brings the tubes in a staggered position vertically, which prevents the gases from having a free, uninterrupted run back to the chimney, thus insuring a more perfect absorption of the heat.

In placing this boiler in position, when it takes the place of old shell boilers, the necessity for tearing up the sidewalk or street is obviated, as it can be introduced into a building through an ordinary window or door—an opening 39 in. square being sufficient for the introduction of a boiler of 350 H.P. The old shell boilers can be cut up by a boilermaker right in position and so taken out and the new boiler put in with but little trouble and expense.

The boiler is built entirely on the interchangeable system, so that any part may be slipped out and a new part introduced at a minimum cost and in a very short time. Thus, by keeping up with the deterioration which takes place in all boilers the same high pressure can always be carried. The company have recently issued an information pamphlet, which gives a detailed description of the boiler, together with other information about water-tube boilers generally.

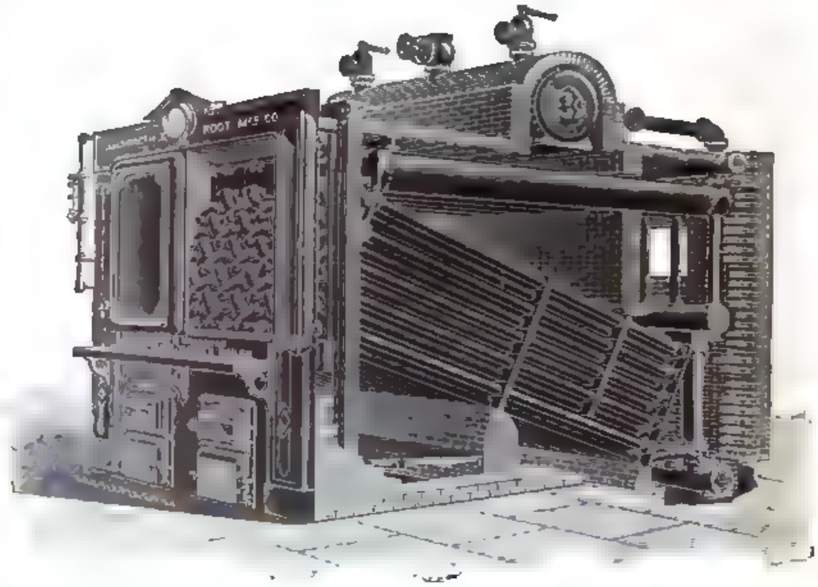


Fig. 7.

SECTIONAL VIEW OF ROOT BOILER.

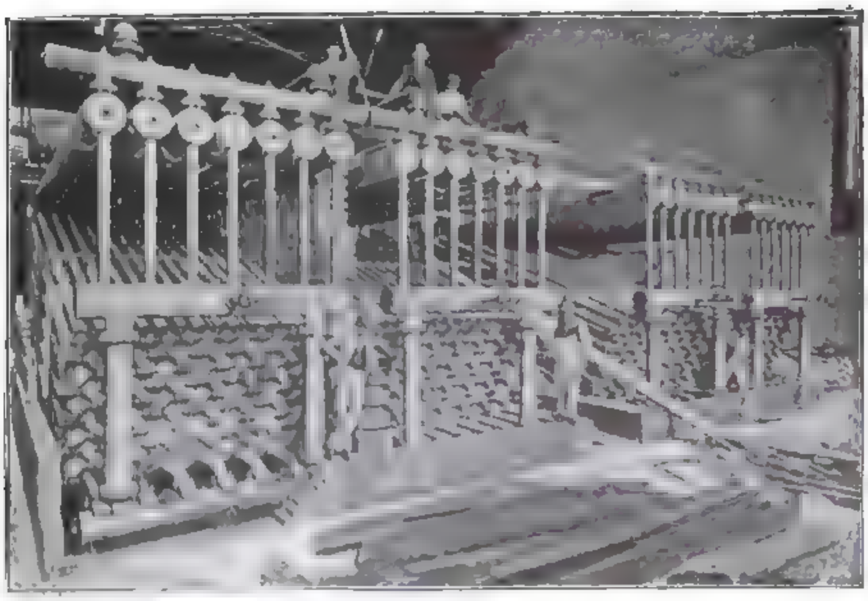


Fig. 8.

BACK END OF ROOT BOILER, SHOWING METHOD OF CONSTRUCTION.

FLEXIBLE FRICTION CLUTCH PULLEY.

An important problem in the transmission of power by machinery is how best to provide for cases where it is necessary to start and stop a shaft or train of shafting which is driven from another shaft revolving continuously.

There are four principal methods by which this may be accomplished. Where the motion is communicated from a pulley on the driving shaft to a pulley on the driven, it may be done (1) by placing a loose pulley alongside of the latter pulley, and shifting the belt from the loose to the keyed pulley to start the latter, or in the reverse direction to stop it, the driving pulley on the first motion shaft being of double the width of the belt; (2) by making the driving belt of such length that it hangs loosely over the pulleys, in which condition there will not be sufficient tension to transmit power, and by applying a "tightener pulley" to the belt to produce the necessary tension for driving; (3) by means of the ordinary jaw coupling attached to one or other of the pulleys, by means of which it may be locked rigidly to the shaft, or allowed to run freely thereon, and (4) by means of a friction clutch attached to one of the pulleys.

The first method of shifting belts is widely used in cases where the belts are narrow and the power transmitted is small, as, for example, in driving machine tools and the like, though even in such cases the practice of substituting the friction clutch is rapidly growing. For wide belts and large powers the shifting belt method is quite inadmissible. The second method can only be used to advantage where one shaft is directly over the other, so that the belt, when slacked off, will hang clear of the lower pulley, which should be the driver. This plan may be used for larger powers than can the shifting belts, but is objectionable on account of the wear and tear on the belt occasioned by its excessive slipping over the pulleys in starting up and until the driven train of machinery is brought up to the speed of the driver. The heat produced is often so great as to burn and injure the belt.

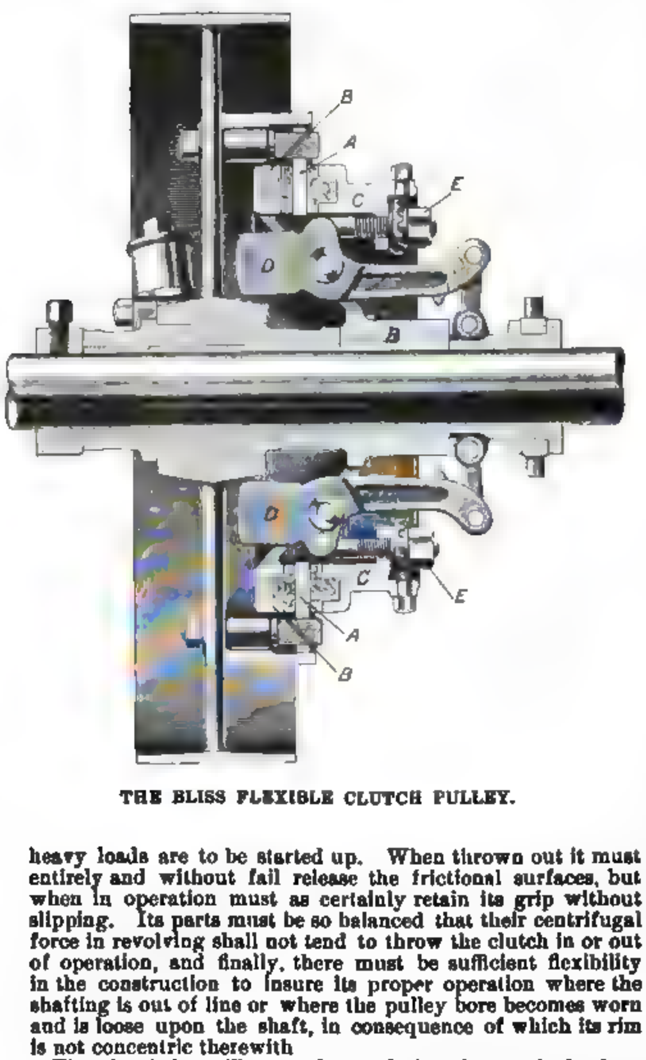
The third method can only be used for very light powers or for very low speeds of revolution, as the shock of starting

suddenly will otherwise rupture the mechanism or throw the belt off the pulleys.

The friction clutch, when properly designed and constructed, possesses advantages which enable it to be used effectively in almost every conceivable case where power is to be transmitted under the conditions here discussed.

The recognition of this fact has of late years brought into the market a great variety of friction clutches, more or less effective.

The requirements of a good friction clutch may be stated as follows: Its parts should be few and simple and require little or no attention, as it is not liable to receive much. It should be capable of being easily and quickly thrown in and out of operation by hand, except in the case of the transmission of very large powers, where it is advisable to operate it by special mechanism. Its frictional surfaces should be so arranged and of such material as to be easily and cheaply renewed when worn out. Its adjustment for wear should be so simple in arrangement that in unskillful hands it cannot easily be subjected to undue strains. It should be capable of being operated so as to apply the frictional contact gradually where



THE BLISS FLEXIBLE CLUTCH PULLEY.

heavy loads are to be started up. When thrown out it must entirely and without fail release the frictional surfaces, but when in operation must as certainly retain its grip without slipping. Its parts must be so balanced that their centrifugal force in revolving shall not tend to throw the clutch in or out of operation, and finally, there must be sufficient flexibility in the construction to insure its proper operation where the shafting is out of line or where the pulley bore becomes worn and is loose upon the shaft, in consequence of which its rim is not concentric therewith

The clutch here illustrated was designed to embody these features, and is being built for the market by the E. W. Bliss Company, of Brooklyn, N. Y. It may be described as follows: The driving pulley which runs loose on the shaft has attached to its arms a ring or driver, into which is loosely inserted a disk, *A*. This disk is made to revolve with the pulley by means of several driving studs secured to the pulley and projecting through slots in the outer edge of the disk. While thus prevented from revolving in relation to the pulley, it is capable of freely moving lengthwise of the shaft, and also of its plane being inclined slightly out of the plane of revolution. Keyed to the shaft is a driver, *B*, which is conical in shape, and has a circular groove turned in its periphery, into which are inserted wooden blocks bearing against the inner face of the flexible disk *A*, as clearly shown in the cut. An opposing ring, *C*, has a similar arrangement of blocks, and held in position by two or more studs not shown in the cut, but which compel it to revolve with the driver *B*, at the same time allowing a longitudinal motion similar to that of the flexible disk *A*. When this ring is drawn toward the opposing driver *B*, the flexible disk is gripped between the wooden blocks, and the whole mechanism revolves together. It will be seen that the required flexibility for improper alignment is amply provided for. To operate the ring *C* two or more draw-bolts placed parallel with the shaft pass through lugs projecting from the inner periphery of the ring. Adjusting nuts with lock screws bear against these lugs.

The bolts are pivoted to right-angled levers, which are in turn pivoted to the driver *B*. The long arm of the levers extend beyond the hub of the driver *B* and are linked to a sliding sleeve on the shaft. This sleeve is moved longitudinally on the shaft by an ordinary hand shifter. When moved away from the driver, the links are brought into an inclined position, which pull the ends of the levers toward the shaft, thus releasing the clutching surfaces. When moved in the opposite direction, or to the position shown in the cut, the links straighten out and form toggles, which produce a powerful grip between the frictional surfaces, and at the same time lock them securely in position.

The operating levers are provided with counter weights *D* to balance the centrifugal force tending to throw them outward from the shaft.

It will be noticed that, as the friction blocks gradually wear away it is only necessary to set up the adjusting nuts until sufficient tension is obtained to prevent slipping under the load, the flexible disk accommodating itself to the adjustment.

The makers of this flexible clutch pulley have designed special tools for producing all the parts so that the clutches can be assembled from stock of parts kept on hand, all these parts being duplicate and interchangeable.

THE TOWER COUPLER.

The cuts shown herewith illustrate the Master Car Builders' coupler now being put on the market by the National Malleable Castings Company. It is known as the "Tower" coupler and is of the knuckle opening class; in operating the knuckle from the corner of the car no additional parts are required either in the unlocking gear or the coupler itself. It has been very carefully designed and the metal has been well distributed to meet the strains encountered in service.

The body of the coupler is made of malleable iron, and the knuckle, lock and pivot pin are of steel. The shank is square for its entire length and the liner blocks are cast on The walls of the shank are thick and well ribbed, but sufficient room is left for the use of a tail bolt if desired, and a slot for the American continuous draft rigging can be added. The knuckle is fulcrumed back far enough to give great strength to both it and the head, and yet smooth action is obtained even on the sharpest curves. The face of the tail of the knuckle is so shaped as to come in contact with the outer face of an opposing knuckle when in the act of coupling, so that it is swung into the closed position through that contact, instead of by contact with the outer face of the opposing knuckle. This is conducive to smooth action in coupling, which is further promoted by the fact that the lock does not have to be raised as the knuckle swings in. This also prevents the binding and failure to couple, to which certain couplers are liable. From fig. 2 of our illustration it will be seen that the buffing strains received by the knuckle are transmitted to the head by means of a broad flat bearing at the end of the tail of the knuckle. A tendency for the knuckle to rotate inwardly under these blows is also resisted at the same point and by a bearing against the vertical wall of the head at a point considerably nearer the fulcrum pin. By its shape and size the knuckle is amply strong to receive and transmit without damage any strains encountered in service.

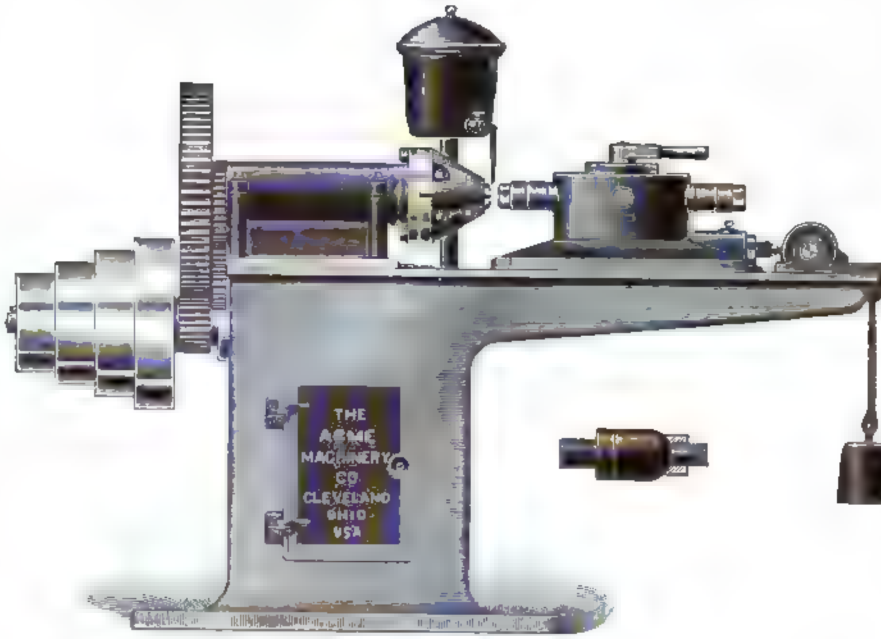
The conspicuous part of the coupler is the lock, which also serves to throw the knuckle open. Its shape will be readily understood from figs. 1 and 6 in our illustrations. In fig. 1 the full lines show the lock in the normal position; and it will be seen then, when receiving the pulling strains, the lock is firmly supported by a vertical wall on the guard arm side of the head, so that it is subjected to no strain other than one of compression. To uncouple, the lock is raised until it strikes the under side of the top wall of the head, being guided verti-

cally in this movement by the bearing of its stem in the bottom wall of the head. If it is desired to simply unlock the knuckle, the lock is held in this position by the unlocking position in the usual manner. If, however, it is desired to swing the knuckle open, the lever of the unlocking gear is lifted still higher, and the lock, pivoting on a ridge on the top wall of the coupler head, is rotated about that point as shown in fig. 1, the stem of the lock disengages from the hole in the lower wall of the head and slides along a groove provided for it. This motion of the lock swings the knuckle open in a way that is perfectly clear from fig. 1. The lock remains in the position shown in dotted lines after the operator has dropped the unlocking lever, and only falls into its normal position when the knuckle closes.

The lock cannot be interfered with in its operation by ice, dirt, or cinders. It is provided with ample bearing surface on the knuckle, the area of contact being 4½ sq. in. It cannot be struck by coupler links, as they cannot enter the head far enough owing to the size of the tail of the knuckle.

The Tower coupler has been repeatedly tested under the drop and for a considerable period in service, and it is said has fulfilled all requirements.

Electrically Operated Mill.—The Columbia Mills, which have recently been built at Columbia, S. C., have introduced the novel feature of independent electrically driven machinery, thus doing away with the necessity for shafting, pulleys and belting. Water power is used to drive wheels having a total capacity of 2,000 H.P., which in turn drive large generators with a total capacity of 1,500 H.P. The mill was started about June 20, but has not yet been in operation for a sufficient length of time to add anything for or against the argument regarding electrically driven machinery.



THE ACME NUT-FACING MACHINE.

ACME NUT-FACING MACHINE.

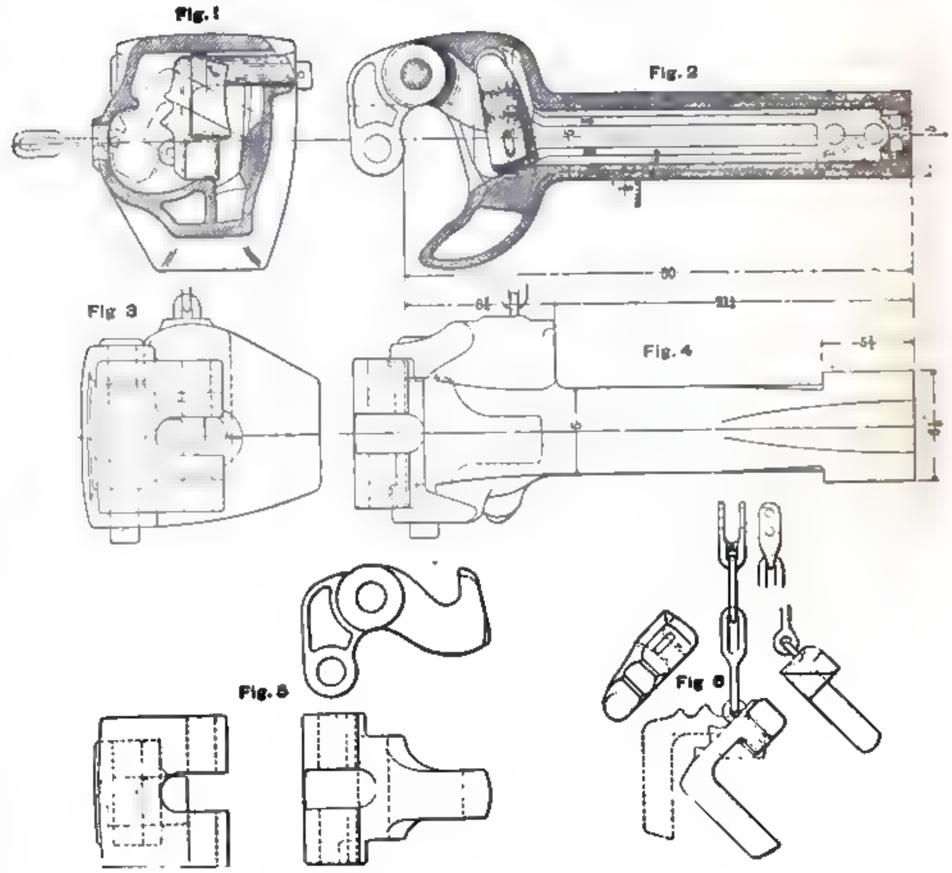
The nut-facing machine which we illustrate herewith is one that is being built by the Acme Machinery Company, of Cleveland, O., and has a number of new and valuable improvements for chamfering and facing nuts and bolts.

The cutting head is arranged to hold three tools of bar steel, one for facing, one for chamfering the corners, and a third to remove the first thread in the nut. They can be removed, ground and replaced in a few minutes.

The spindle to which the cutter head is attached is driven by a four-step cone pulley, and geared 4½ to 1, thus having sufficient power to face the large nuts with ease and the additional advantage of facing the smaller sizes at the proper speed.

On the carriage is mounted a turret with a broad key to keep it in line, and a lever nut to clamp it in position as shown. The carriage is moved forward to the cutting head by means of a cam journaled on the ways of the bed. This cam is driven by a worm and worm wheel, thus giving the carriage a steady, forward movement, and the weight hanging from the front end of the bed returns the same after the nut has been faced.

The advantage of a turret to hold the nut arbors is that the nuts can be removed and replaced much quicker and with less exertion than is possible on a machine where the arbors revolve and the cutting head remains stationary.



THE TOWER VERTICAL PLANE COUPLER.

AERONAUTICS.

UNDER this heading we shall hereafter publish all matter relating to the interesting subject of Aerial Navigation, a branch of engineering which is rapidly increasing in general interest. Mr. O. Chanute, C.E., of Chicago, has consented to act as Associate Editor for this department, and will be a frequent contributor to it.

Readers of this department are requested to send the names and addresses of persons interested in the subject of Aeronautics to the publisher of THE AMERICAN ENGINEER.

THE CRANKS' INNINGS.

UNTIL quite recently the attitude of the British press toward aerial navigation has been one of contemptuous silence. It has not, like the American press, published as news facts, fictions, fallacies, and flights of fancy, but has resolutely ignored experiments and correspondence on flying machines.

Now this is all changed; and since Mr. Maxim's flight of July 31 the English papers are giving much space to accounts of his apparatus, of his paper before the British Association, and of his article in the *National Review*.

All this accompanied with many disquisitions and comments, some of which "go for" Mr. Maxim on account of his supposed bloodthirsty turn of mind in designing a new and terrible war engine. Mr. Maxim has kept the discussion going by many letters to the papers, and one of these, published in *Industries and Iron* of August 31, has led to a series of amusing epistles.

In this letter Mr. Maxim had stated that if the English, "from a feeling of pure patriotism, would like to see the Anglo-Saxon the first man in the air, they have only to raise £50,000 ($250,000), when we shall be able to cross the British Channel in about one year from date."

This offer having produced several comments that, if the results could be accomplished, the money would be well spent, the cranks broke loose in an effort to "cut in ahead."

The race seems to have begun in the *Morning Leader* of September 8 with a "small master baker, a self-taught man and an inventor," who sent a friend to the paper to say that he considered Mr. Maxim's offer much too high, and that he (the baker) had invented a superior flying machine, the propelling power of which was at present a secret, but that he would guarantee to build a flying machine within 6 months that would go across the Channel and recross for the sum of $25,000. As a prerequisite, however, a capitalist was wanted to advance the money for taking out patents, making models and building the machine.

Notwithstanding this alluring reduction in time and amount, and the proposal to cross twice instead of once, this offer had no takers; so, a few days afterward, another inventor from Walthamston offered to construct in 6 months for $15,000 a flying machine (not a balloon) to cross the Atlantic to New York in 3 days. This performance, he said, would be quite safe, as the steering gear, which was a secret, and the mode of alighting had been all thought out, while "Maxim creates a buoyancy by his mechanism which is not in the thing itself, and if anything were to go wrong the whole would lose its buoyancy and come down flop." This inventor had made drawings, and he also needed a capitalist to advance money for a working model. When asked if he really thought his invention practicable, he replied, "Think! I know! I know there is the buoyancy, and must be, because I have looked all round the question."

There being still no takers, the next day brought four letters to the *Leader*. One man offered to show (confidentially) his plans and papers to any person the editor might appoint; the second could guarantee a perfect flying machine within 2 or 3 months; the third said that the most wonderful inventions had been worked out in a very short space of time; while the fourth offered for $1,250 to design the air ship, "but I'll take no risks."

This succession of underbids, like those at a "Dutch auction," not having tempted the thick-skulled capitalists, the inventors next endeavored to enlighten the editor of the *Leader* personally. He thus describes one of the interviews:

"Last night I was honored by a visit from a man who introduced himself with a remark about being ready to knock spots off Mr. Maxim. My visitor was 6 ft. 1 in., and I am 5 ft. 3 in., so I immediately derided Mr. Maxim on principle.

"'Look here,' continued the genius; 'have you seen what Lord Kelvin says?' I shook my head, and he read the following at a fearful pace: '"The force required to keep a narrow rectangular plane moving with constant velocity V, in a direction perpendicular to its length l, and inclined at a small angle i, to its breadth a is 2 pi V^2 sin theta, cos theta $l\ a$; which is 4 pi cos theta sin theta times (or if sin theta = 8 one hundred times) as great as the old miscalled 'theoretical' result."'

"'That's just what I've always said,' I remarked nervously, getting behind a chair; 'it's devilish interesting, too, and I wish you would read it again.' He did so, and I kept assenting, and remarking 'Cos theta, yes, yes; 2 pi, of course,' and so on to make the giant in front of me think I knew all about it. Then he turned from Lord Kelvin's formulas and began to talk about his own invention.

"'I have made flying machines for years,' he began—'that is to say, models, or, to be more precise, drawings of models; in fact, in some cases I have not proceeded so far as the drawing, but have the design in my head.'"

It is needless to say that the inventor was dismissed as quickly as was possible.

Then more letters came in to the *Leader* proposing "aerial locomotives," "the conquest of the air," a small model for $50, several navigable balloons, an air ship propelled by cordite, etc., almost all of them betraying blissful ignorance of the enormous mechanical difficulties to be overcome. Other newspapers, not to be outdone, opened their columns to correspondents, notably to a Liverpool man who does not want to expose his secret, but is confident of satisfactory results for $12,500; to another Liverpool man who disparages the first, condemns steam and electricity as unsuitable, and proposes an oil motor, and to "Poor Pat," who says that he would like it to be known that Old Ireland is not altogether asleep in the matter, and proposes—can he be a Fenian?—explosives as a motive power; while the editor asks, in comment, "What's the matter with the almighty dollar as a motive power?"

The correspondence was finally closed in the *Morning Leader* of September 21 with a letter from Mr. Maxim, in which he gives an amusing account of some of his experiences with inventors. One man, after a great deal of study and experimenting, has at last succeeded in reversing the force of gravity and in making it pull up instead of down; or, in other words, he makes it pull in any desired direction. If his machine weighs a ton, he simply changes the direction of its gravity, very much as you would an algebraic quantity by adding a + or — sign, and you rise or descend at pleasure; or, by making it pull horizontally, you cannot fail to fly at a great velocity.

Another genius has been experimenting and had satisfied himself that a steam engine "wouldn't do," and says he has succeeded in extracting the energy from petroleum oil. This concentrated energy he can put in a bottle, and weighs about

8 lbs. to the pint, or it may be compressed into cakes, like soap, and a small piece of it weighing only a few pounds suffices to give off all the energy necessary to work a flying machine or to drive a ship across the ocean in a few hours, "making its oxygen as it goes."

Irishmen and anarchists think that anything can be made to go with nitro-glycerine, and believe that always affords the means of a very rapid ascent in this world. Another man, who must have been a nihilist, proposed to create a vacuum all over the top of a flying machine by means of a syringe, so that the air below it would press it upward with a force equal to 15 lbs. per square inch.

A little chap who, Mr. Maxim says, was only about half his size, came over from America. "He could talk science and dynamics by the mile, and I was delighted with him, especially as he was so very small and light. He could build flying machines by the million with his mouth, but when I set him to work I found that his mouth was the only organ about his body that was in working order or would turn out any product."

Visitors with the same general characteristics look in occasionally at the office of the AMERICAN ENGINEER.

DISCUSSION BY J. BRETONNIÈRE, OF CONSTANTINE, ALGERIA.

MR. FRANK H. WINSTON'S PAPER ON "THE SECRET OF SOARING."*

MR. FRANK H. WINSTON maintains that, in accordance with the observations which he has made, a bird has recourse in soaring flight to four methods. The first method is a horizontal or ascensional movement. It is the result of the *vis viva* already acquired. The second is a movement ahead and downward, the result of sliding on the air. The third is an irregular movement ahead and rising against a wind of variable intensity. It is the combination of the two first methods, but coupled with the existence of an intermittent wind. The bird advances in the descent along the wind during the period when the wind moderates, then hurls itself against a blast of wind which follows. Sometimes in this method the bird, by a circular movement after its ascension, moved with the wind, which has moderated, and, by a new circular movement, turns to make use of the momentum which is the result. The fourth method is the floating with the wind when the latter is blowing at its highest, followed by a return in a circular movement against the wind when the latter has lost its resistance.

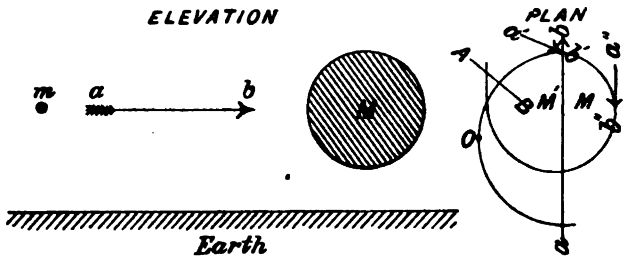
From this description, and in accordance with this theory, there is no question of sliding transversely to the wind, which, in accordance with our conception of gliding value, gives the bird speed and the *vis vive* which it afterward utilizes against the wind. Mr. Winston has very clearly explained at the beginning of his description of this third method the effect of natural *rafale*; but he does not appear to have seized upon the relationship which exists in many cases between his first and his second method; the reunion of which constitutes then for the bird what we call the relative *rafale* by zigzag.

Mr. Winston has not taken into consideration the transverse gliding which precedes the return against the wind. According to him, the bird carried along by the wind changes direction by the position given to his wings; he crosses the wind with a speed almost equal to that of the wind, gaining thus in height, and then by a similar movement faces the wind with the velocity which he has attained. Well, no! The bird carried by the wind with an equal speed of fair wind as that of the wind, and has no means of transforming this speed into an equal speed and transversely to the wind. And if he does not have these means because the air upon which alone he can take support flies away before him, let us examine this point.

Suppose in the figure that a mass, m, that is perfectly elastic is advancing with a speed, v_1, in the direction $a\ b$ parallel to the earth toward the mass M, which is at rest, and which is also perfectly elastic and very large relatively to m. After the shock which is produced m will have in its new direction a speed approximately v_1, and which would be equal to v_1 if M were infinitely large relatively to m. This new direction, if the blow were exactly normal, would be in exactly the opposite direction, $b\ a$ to $a\ b$. It could also be transversely to it. Let us now admit that the system of masses m and M had a speed, v, in the direction $a\ b$ relatively to the earth, m preserving its direction and its speed first relatively to M, so that we may consider the earth as having a movement in the direction $b\ a$ and at a speed, v, relatively to the same system. After the blow m would separate from M in its new direction with the same speed as in the preceding case. This new direction might, for example, be transversely or backward—that is to say, along the line $b\ a$. In this latter case, as the earth advances at the same time as m along the line $b\ a$, the speed of m relatively to the earth will be reduced to v_1 and v. But v_1 being equal to $V - v$, the backward speed of m having struck M, will be $(V - v) - v$ or $V - 2v$. V and v, we recollect, represented respectively m and M relatively to the earth before the blow. What precedes shows that if a mass, m, had struck the mass M, which is infinitely large horizontally, the blow will give the mass m in its new movement relatively to M, a speed equal to the speed of m diminished by that of M, and that the new speed of m relatively to the earth, if m is thrown back in a direction where, too, its first movement will be equal to the speed of m diminished by twice that of M.

But we must not lose sight of the fact that V is the sum of two positive quantities, v_1 and v, and that it cannot be smaller than v. If we should consider that the quantity V is smaller than v, no blow of m against M would be possible, and consequently no change in direction would follow the blow.

The bird carried along by the wind is the mass m. The moving mass of air is the mass M. We think that in the blow of the mass M against the mass m we presented the best conditions of elasticity as that motion of the bird, called *passade* by the old practitioners, is called; but we consider that it is necessary to take the speed of the two masses into account. If the bird—that is to say, the mass m—has a speed of 60 miles per hour, composed of the speed of the wind, it carries it equal to 20 miles and a gliding speed of 40 miles in the direction of



this wind, it would be able to obtain, by hurling itself against the air, a transverse speed of $60 - 20 = 40$ miles per hour. If it should turn directly into the opposite direction its speed will be relatively to the earth only $60 - 2 \times 20 = 40$ miles per hour.

But if the speed of the bird is less than or merely equal to that of the wind, which is the hypothesis of Mr. Winston, a blow is no longer possible, and every theory founded on this means of changing direction is erroneous. But it may be remarked that if we do not find Mr. Winston's theory best on this foundation we will, nevertheless, admit with him, according to the paper which I presented at the Conference at Chicago, that in the part $b^1\ b^2$ of the spiral (see the engraving), where $a\ b$ represents the direction of the wind, the bird makes a turn against the wind by an ascensional movement, and we would give some further explanations in regard to the details of this subject. It will be granted, we think, that the bird reaches the point b^1 of the curve with a speed moving along the line $a^1\ b^1$ slightly oblique and backward relatively to $a\ b$, by which he would naturally tend to penetrate the earth mass M which lies beyond the line $a\ b$; then, by successively modifying his curves by a suitable arrangement of the winds, he rises directly in running along the line $a^2\ b^2$, his movement having been constantly on the rise from b^1 to b^2. But as the bird—at the point o of the spiral—is already subjected to the effect of the wind and which was buried in the mass m^1, which is practically the same as M—that is to say, having the same speed and the same direction. Has it been possible for him to transform his movement on reaching b^1 with a speed and direction $a^1\ b^1$? It is here that the difference between Mr. Winston's theory and my own appears. My opinion is that the bird has glided across the wind holding the steepest possible line of upward inclination of his body and wings, and as their observation of the spiral traced will show, has followed a direction, $A\ b$, and has practically turned toward the central part of the figure which he describes. This inclination of the line of greatest rise causes a gliding composed of two elements, one parallel to $a\ b$ and in a contrary direction, the other in a transverse direction. It will be ad-

* Published in AERONAUTICS of October, 1893.

mitted that in the run $o\ b$ the bird would have varied the inclination and direction $A\ b$ in such a way that during the perpendicular element to $a\ b$ it preserves its transverse action while the parallel action to $a\ b$ at first resists every new variation, and then gradually suppresses that which already exists, and, finally, acts upon the bird at the moment of its arrival at b^1, where he commences the return movement to the back, so that even from the point b^1 the direction of the bird becomes that of the oblique line $a^1\ b^1$. The drifting motion which the bird is subjected to at o, and which only gradually disappears, the trajectory $o\ b$ is not really a transverse straight line, but a curve elongated in the direction of the wind.

In consequence of this theoretical standpoint which I have laid down, I am impelled to offer two objections to Mr. Winston's theory, based upon actual facts of soaring flight such as have been observed.

First objection: That the air is subjected to variations in speed there can be no doubt; but do these variations present themselves with the intensity and especially with the regularity which would be required in order to bring Mr. Winston's hypothesis in accordance with the facts? We cannot admit that they do. On the one side the spirals of the same series which a bird traces occur in intervals of time that are practically equal. On the other hand, the average operation of early spiral is most frequently, according to my observations, about 12 seconds. In accordance with Mr. Winston's theory, then, there must be an intermittent action of the wind every 6 seconds; a calm succeeding a gust, a calm, and so on. What wonderful regularity in an irregular wind! Such a fact as this would need to be very carefully demonstrated in order that it might be admitted. Now, not only has no such demonstration been made by Mr. Winston, but even the contrary fact may be deduced from the engravings which accompany Professor Langley's paper on the "Internal Work of the Wind." In these plates we see, it is true, that there are rapid variations in the speed of the wind, but nothing which resembles the intensity and especially the regularity which corresponds to the regular succession of the spirals.

Second objection: According to Mr. Winston, the bird adapts its wings with the winds, and it returns in the contrary direction to the intermittent action of the wind. It follows, then, that if a great number of birds were soaring together in the same space they must exclude their spirals simultaneously either in the direction of a wind or a contrary direction. Now, no such simultaneous movement occurs in actual practice. Not only the birds turn, some in one direction and some in another, but it is readily seen that the circular space which they pass through is divided into a certain number of sectors and may have a bird in each sector at the same instant.

EXPERIMENTS WITH THE NEW MILITARY BALLOON ON THE TEMPLEHOF PARADE GROUND, BERLIN.

MILITARY BALLOONING IN GERMANY.

We reproduce from the *Illustrirte Zeitung* a picture of a new captive balloon which has just been tested in Germany. Interesting experiments with this apparatus were made on the Templehof Parade Ground near the barracks or caserne of the balloon corps. Hitherto these aeronauts have had great difficulty in keeping a balloon sufficiently still to enable the aeronauts to make precise measurements and delicate observations. This difficulty has now been overcome by means of a cylindrical captive balloon, at one end of which two small horizontal balloons are fixed. This balloon is attached to a windlass on a specially constructed wagon. About 100 yds. from the wagon a pulley is fixed on the cable with 30 depending ropes, each of which is held by a soldier. From this point the balloon rises in a slightly oblique direction into the air, and is found to remain sufficiently stationary to enable the two aeronauts in the car to make the most exact measurements and observations. The object of the pulley is to regulate the height of the balloon and to move it from side to side. As the pulley is advanced, so the balloon descends; as it is pulled back toward the wagon, so it ascends. Movements of the pulley to the

right or left produce corresponding movements in the balloon.

The novel features appear to be twofold: 1. An elongated cylindrical form with hemispherical ends, which has hitherto been suggested but not tested. It will be noticed that the effect is to raise up the nose of the balloon to the wind (the restraining rope being fastened to the car) and to impart greater steadiness than in the globular balloon. 2. A movable pulley operated by soldiers, to regulate quickly the height of the balloon and to move it to the right or left when there are obstacles in the field of operations. These two novelties seem to have worked very well and to promise considerable additions to the use of captive balloons in warfare.

A THEORY OF SAILING FLIGHT AND AEROPLANES.

To the Editor of THE AMERICAN ENGINEER AND RAILROAD JOURNAL:

Mr. Chanute, the esteemed author of one of the most excellent and complete aeronautical books of to-day, to wit, "Progress in Flying Machines," has thought the modest papers which I sent to the Conference on Aerial Navigation in Chicago, and which have since appeared in AERONAUTICS, worthy of his discussion, and has courteously indicated those points which seemed to him doubtful or obscure. I will endeavor to resolve those doubts and obscurities as briefly as possible.

In No. 9 of AERONAUTICS (June, 1894), in the discussion of Mr. Bretonnière's paper on Sailing Flight, Mr. Chanute also mentions my article among others, and says: "Mr. Kress, who argues that the bird gathers energy by passing from one stratum of air into another stratum blowing at greater speed, but who furnishes no evidence that air is usually stratified in that peculiar way;" and further, "Even if it were in regular strata, instead of the irregular pulsations shown by the diagrams of Professor Langley."

It will perhaps be best to copy here the sentences of my article which were called in question in the excellent English translation: "There are *streaks* and *waves* of air of different speeds, generally increasing in velocity with the altitude;" and further, "It must be *particularly* noticed that the more rapid currents of air *need not* necessarily be above each other."

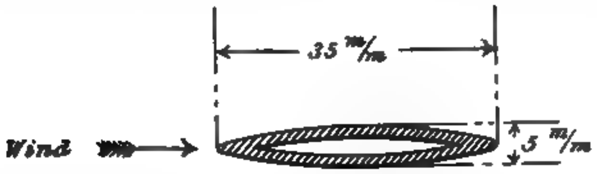


Fig. 1.

The assertion is nowhere to be found in my article that the different velocities of the air must be arranged the one above the other in sharply defined layers; on the contrary, I assume it as self-evident that the differences in wind velocity are quite irregular in their speeds and direction, so that my theory does not conflict at all with Professor Langley's diagrams, and these irregularities in the wind velocity cannot have any influence on the correctness of my theory. In the sentence, "Let us represent in fig. 1 an ideal condition," . . . I have clearly indicated that my diagram has only an ideal significance, in order to explain my theory in the simplest and briefest manner.

In No. 10 of AERONAUTICS (July, 1894), in discussing my aeroplane, Mr. Chanute questions the formulæ used by me. I have based my calculations on the formulæ of Lilienthal and Professor Wellner, as well as on my own experience with flying models. My model of the "Aeroveloce," on the occasion of my last experimental lecture in 1893, was carefully measured and weighed by my fellow aviators. An account of these experiments will be found in No. 708 of the *Zeitschrift für Luftschiffahrt*, Berlin, 1892, and in the *Neue Freie Presse* of Vienna, No. 9,829, January 6, 1892.

Even when we succeed in actually compassing artificial flight, there will probably be no agreement among aviators concerning aerodynamic formulæ. I have had some remarkable experiences in this direction. According to formulæ used until quite recently, my model, in proportion to the size of its wings, should not weigh more than 8 to 18 grams in order to fly at all with a velocity of 4 meters. As a matter of fact, it weighs 245 grams, and actually flies and rises. Isn't that queer? Still more droll is the fact that my models flew as long ago as 1879 and 1880, and were shown publicly in Vienna before the Chamber of Commerce, the Railway Club, the Aeronautical Society and other large bodies, with perfect success; and that, notwithstanding this, almost to the present day many theorists calculate the "lift" according to antiquated formulæ, by which neither the birds nor any artificial apparatus could ever be made to fly.

Mr. Chanute knows very well what contradictions prevail on the subject. I will not argue any further whether, in calculating the "drift," an angle of 3° or of 6° should be assumed in my aeroplane machine, but I will pass at once to the more important point—that is, to the resistance of the "spars, posts, braces, etc." This I neglected to introduce in the calculation of my machine, and thus drew upon myself a well-deserved correction.

The "spars, posts, braces, etc.," which carry the car, shafting, journals, etc., and connect these with the wings, are so arranged that a part of them are shielded from the direct wind by the wings; the parts which remain exposed to the wind will aggregate about 50 meters in length; these ties, struts, etc., will consist of "Mannesman" steel tubes of about $1\frac{1}{4}$ millimeters wall thickness, pressed nearly flat; they are hollow elliptic steel tubes placed with the sharp edge to the wind, being 35 millimeters in breadth and 5 millimeters in thickness in the middle part; they will sustain a tension of 3,000 kilograms, and weigh $\frac{3}{10}$ of a kilogram per meter. The wind resistance of this cross-section is reduced to $\frac{1}{5}$ by the pointed elliptic form (see fig. 1). Thus the resistance of these "spars, posts, braces, etc.," will be: $W^{iv} = 50 \times 0.005 \times 100 \times \frac{1}{8} \times \frac{1}{5} = 0.63$ kilograms, and not 16.67 kilograms, as Mr. Chanute erroneously assumes.

This is for a velocity of 10 meters per second, which, for an aeroplane, must be considered a minimum. For practical work we must endeavor to reach a velocity of 30 meters per second. At this last velocity the resistance of the car and the framework alone would be 172.5 kilograms, according to M. Chanute, and the necessary work $1,725 \times 30 = 5,175$ kilogrammeters per second. Allowing 50 per cent. for the efficiency of the screw, $2 \times 5,175 = 10,350$ kilograms $= 138$ H.P. would be necessary to simply overcome the horizontal resistance of the apparatus.

It will be clear to every aviator that structures producing so great a resistance would be totally impracticable in artificial flight. I am willing to admit, however, that my unintentional omission in describing the details of my apparatus was the main cause of this misunderstanding. WILLIAM KRESS.

RECENT AERONAUTICAL PUBLICATIONS.

WE shall hereafter publish brief references to such publications and articles concerning Aeronautics as seem to possess interest for our readers.

Flying Apparatus. Otto Lilienthal. *Zeitschrift für Luftschiffahrt und Physic der Atmosphere.* Berlin, June, 1894. Herr Lilienthal discusses from a general point of view the design and application of flying apparatus.

Analysis of the Functions of a Bird's Wing. S. D. Mott. *Scientific American* supplement, August 11, 1894. Proposes imitation of wing flapping by the rotary oscillations of concave-convex surfaces driven by electricity.

The Maxim Flying Machine. Illustrated. *Engineering*, London, August 10, 1894. Describes Maxim's apparatus and last experiment.

Maxim's Flying Machine. Illustrated. *The Engineer*, London, August 10, 1894. Describes Maxim's apparatus and flight.

Maxim's Triumph and Disaster. Illustrated. *Invention*, London, August 11, 1894. Discusses Maxim's flight and experiments.

The Maxim Flying Machine. Illustrated. *Invention*, London, August 18, 1894. Illustrates Maxim's machine as landed after the accident.

Maxim's Flying Machine. Illustrated. *The Practical Engineer*, London, August 24, 1894. Illustrates details of construction of the apparatus.

The Evolution of a Flying Machine. H. S. Maxim. *The Hardware Trade Journal*, Birmingham, August 31, 1894. Gives in full the paper read before the Mechanical Section of the British Association, at Oxford, by Mr. Maxim, August 10, 1894.

Will Man Ever Fly? A Symposium. Boston *Globe*, September 9, 1894. Opinions of six experts as to the probabilities of success.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

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(ESTABLISHED IN 1832.)

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NEW YORK, DECEMBER, 1894.

1895.

On the approach of a new year an editor always feels that he ought to have something to say to his readers and patrons which will be indicative of his plans and purposes for the future. If he has had any novel enterprises on the stocks he then launches them, and breaks his bottle of wine with as much *éclat* as the prospects and circumstances will permit, and tells his readers with more or less confidence, according to the degree of prosperity in which he is basking or the adversity which he is enduring, "where he is at." But both people and papers in their youthful years undertake more new enterprises and make more promises than those who are gray-headed do, and who have kept up a more or less steady gait for half a century or more, and have entered, perhaps, on the last decade of three score and ten. With 1895 the *American Railroad Journal*, with which the AMERICAN ENGINEER is now incorporated, enters upon the sixty-third year of its life. Its first number appeared January 1, 1832, and since then, with a few temporary gaps, it has had a continuous existence. 1895 will be the ninth year that it has been conducted under its present management. It has maintained its character and position during all that period, and emerges from the general financial and business depression—which is now happily passing away—with those features which have heretofore made it attractive more fully developed than ever. It has been the aim of its editors to bring each number nearer abreast with the advancing march of engineering and mechanical science and art, and it is more carefully edited, is better illustrated now than it has ever been, and its size and the quality of its typography are fully maintained. During the year 1895 no backward step will be taken; but in each successive month whatever occurs which, in the opinion of its editors, will interest mechanical engineers most will be reported, published, illustrated, or commented on. Each number of the paper will contain, as heretofore, not less than 48 pages of reading matter. Its special features, together with its illustrations of various engineering works, new machinery, etc., editorial comment on current engineering topics, original contributions and articles written especially for its pages, selected matter from foreign and domestic sources, book notices and reviews carefully written, personal items, condensed paragraphs of information collected from everywhere, engineering and mechanical notes and news, descriptions of newly patented inventions, and other information within reach of its editors, make it one of the most attractive journals now published for engineers, manufacturers, mechanics, draftsmen, inventors and students.

To all who are engaged in producing anything which pertains to mechanical engineering, railroad operations, or marine construction, it is an influential medium for making their occupation and their products known. All who contemplate making an effort to extend their business during the coming year are solicited to give to the AMERICAN ENGINEER AND RAILROAD JOURNAL at least a share of their patronage, which it will be the aim of the editors of the paper to present in such a form as will do the advertisers the most good. Rates will be given and position assigned on application, and, if desired, forms of advertising will be prepared and engravings made adapted to illustrate the business which is to be extended. For any further information address

M. N. FORNEY, *Editor and Proprietor*,
No. 47 Cedar Street, New York.

EDITORIAL NOTES.

THE *St. Louis*, a brief description of which was published in our last issue, has been launched amid apparently great rejoicing at the Cramps' Yard. It is indeed a cause of congratulation that the American Line will soon become an American line in fact as well as in name, and the special act of Congress which admitted the *Paris* and *New York* to American registry is thoroughly warranted by these new additions to vessels flying the flag of the United States. That the speed of the *St. Louis* will be well up to the requirements of the contract there is no reason to doubt, for the Cramps are not in the habit of building vessels that prove to be laggards, as is evidenced by the premiums won by the *Columbia* and *Minneapolis*.

THE Canadian Society of Civil Engineers has taken a step in the direction of securing compensation for professional service in a line with the practice abroad. At a recent meeting a resolution was adopted in which the practice of submitting plans and estimates without compensation to small municipalities that seek professional advice gratuitously was condemned. That the practice has its hardships for the consulting engineer there can be no doubt, but the fact that large establishments, with a corps of engineers and draftsmen at their disposal, are ready and willing to submit plans and estimates free of cost in the hope of procuring the subsequent contract, forces the little fellows to follow the same line of conduct or be crowded out

of existence. It is an unfortunate condition of affairs, and one that is undoubtedly frequently taken advantage of by unscrupulous men in order to secure professional advice free of charge; but it is difficult to see how the action of the society can change the state of affairs that they so deplore.

HOW CAN THE FUEL CONSUMPTION OF LOCOMOTIVES BE DIMINISHED?

In the AMERICAN ENGINEER for July, page 295, of the current volume, there was published a report, which was submitted to the last convention of the Master Mechanics' Association, of the comparative performance of Mr. Webb's London & Northwestern compound locomotive *Greater Britain*, and two engines—one of them the celebrated No. 999—of the New York Central Railroad. In the September number, page 428, we published another report of a test of an engine of the same class on the same road. In the last number, page 517, a report of a remarkable test of an eight-coupled compound, and an exactly similar simple freight locomotive on the London & Northwestern Railroad, was reprinted from the *Railway Engineer*. The *Engineer* of November 2 contains engravings of two of the most recent examples of English passenger locomotives built by Mr. Dean, the Locomotive Superintendent of the Great Western Railway. One of these is what in England is called a "single" engine—that is, it has only a single pair of driving-wheels; the other is a "coupled" machine, and has two pairs of drivers. Both have leading trucks and inside cylinders. With the description of these machines a somewhat meager report is given of their performance. These five reports, then, it is thought, represent the best performance of modern locomotives, and the principal figures contained therein have been summarized in the appended table. It should be said, however, that the performance of Mr. Dean's engines, which is reported, is not the result of a special test, but is the average performance in daily use, extending over a period of two years. Neither are the figures representing the weight of train accurate, but are "estimated," so that doubtless Mr. Dean could make a somewhat better showing if he subjected his engines to special tests, as the other engines were. It should also be pointed out that only the performance of his coupled engines is reported. The *Engineer* says that the Great Western Railway is nearly level, and in that respect resembles the New York Central.

The table is interesting, as it enables us to compare the performance of some of the best types of simple and compound locomotives of the most recent design, and also what are perhaps the best and most powerful types of English and American express locomotives. While the table enables us to compare the performance of Mr. Webb's compound passenger engine with one of our best simple machines, we have no data for making a comparison of the fuel consumption of American compound engines. Mr. Webb's figures enable us to see what the relative fuel consumption of his compound freight engines was in comparison with one of his simple engines of almost exactly the same type; but our table does not give any similar data concerning the fuel consumption of our best American simple or compound freight locomotives, although doubtless such figures would be obtainable. It must be said, though, that the advocates of compound locomotives in this country are a little chary about giving full reports of their fuel consumption.

Locomotive	Kind of Locomotive.	Weight of Locomotive and Tender in Working Order.	Weight of Cars in Train and Contents.	Ratio of Weight of Locomotive and Tender to Weight of Cars and Contents.	Total Distance Traveled by Train.	Average Speed, Actual Running Time.	Consumption of Coal per Mile, Including Raising Steam.	Consumption of Coal per Mile per Ton of Cars and Contents, Exclusive of Locomotive and Tender, Including Raising Steam.
		T.* Cwt.	T.* Cwt.			Miles per Hour.		
"Greater Britain," London and North Western Railway	Webb's Compound Four-Coupled Passenger	77 2	160 8	1 to 2.08	3,588 mi.	47.66	31.07 lbs.	2.979 oz.
Number 888, New York Central Railroad	Buchanan's Simple Four-Coupled Passenger	89 6	162 14	1 to 1.82	1,776 "	52.24	34.69 "	3.300 "
" " " " " "	Buchanan's Simple Four-Coupled Passenger	89 6	180 12	1 to 2.02	2,848 "	51.13	35 "	2.960 "
Number 999, New York Central Railroad	Buchanan's Simple Four-Coupled Passenger	91 0	279 0	1 to 3.06	1,287 "	45.42	39.21 "	2.180 "
" " " " " "	Buchanan's Simple Four-Coupled Passenger	91 0	186 10	1 to 2.05	2,248 "	50·50	31.04 "	2.662 "
" " " " " "	Buchanan's Simple Four-Coupled Passenger	91 0	......	....	296 "	50.50	12.87 "	2.26† "
London and North Western Railway No. 2524	Webb's Simple Eight-Coupled Freight	76 2	698 5	1 to 9.17	96 "	17.74	71.49 "	1.65 "
" " " " " " 50	Webb's Compound Eight-Coupled Freight	75 17	691 15	1 to 9.12	96 "	17.74	57.8 "	1.325 "
Achilles Class, Great Western Railway of England	Dean's Simple "Single" Passenger	81 10	200	1 to 1.227	....	51.77	31.0 "	2.48 "
Achilles Class, Great Western Railway of England	Dean's Simple "Single" Passenger	81 10	200	1 to 1.227	....	51.34	33.0 "	2.64 "

* 2,240 lbs. † Per ton of weight of engine and tender.

It was remarkable that the report made to the Convention of the Master Mechanics' Association attracted so little attention. The members of the Association who heard it did not seem to fully comprehend the significance of the figures it contained. At the time that Mr. Webb made the test of his *Greater Britain* and published the report of it, those who studied the report saw at once that it indicated a most remarkable economy of fuel consumption.

In a carefully prepared table, which was published in the AMERICAN ENGINEER of December, 1891, page 530, it was shown that with passenger trains the average consumption of coal on a dozen different roads, which keep careful accounts, was a little over ½ lb. (.515 lb. = 8¼ oz.) per ton per mile of cars and their contents, exclusive of engine and tender. This, it must be remembered, was at the average rate of speed of such trains, which is very slow. On the Philadelphia, Wilmington & Baltimore Line it was shown, in a table published in February, 1892, page 54, that the allowance of coal to engineers for running their through passenger trains

from Philadelphia to Washington was .419 lb. = 6.7 oz., while on the Fort Wayne Road for through passenger trains it was from .30 to .36 lb. = 4.8 to 5.76 oz. This was at speeds averaging probably less than 40 miles per hour. The fuel consumptions on passenger trains per ton per mile are given in our table herewith, in the order of their magnitude, 3.3, 2.979, 2.960, 2.662, 2.64, 2.48, 2.26, 2.180 oz., at average speeds varying from 45.42 to 52.24 miles per hour. It will be seen that the difference between these figures and those quoted above is enormously great. Roughly stated in the best performance of locomotives the fuel consumption is *only half* that of the average performance on well-managed railroads. It is not only in passenger service either in which this difference exists. The average consumption of coal with freight trains on the dozen roads referred to was .215 lb. = 3.44 oz. per ton per mile. The average allowance of coal for freight trains on the Philadelphia, Wilmington & Baltimore Railroad (see the American Engineer for February, 1892, page 54) was .253 lb. = 4.048 oz., while Mr. Webb's simple engine burned only 1.65 and his compound engine 1.325 oz. per ton of cars and contents per mile; the average actual consumption being again over twice as much as it was in the test referred to.

Of course persons who are familiar with the conditions which prevail when such tests are made understand the reason for the great difference which has been pointed out. Doubtless in all the tests—excepting, perhaps, those on the Great Western Railway of England, the data of which are taken from the ordinary work extending over a considerable period —the engines were first in as nearly a perfect condition as it was possible to make them; next, the fuel was probably the best that could be obtained; and third, the utmost care and the most skillful and careful men were employed to produce the results which are reported. He would be a very sanguine person who would for a moment indulge in the dream that engines can be maintained in conditions of maximum efficiency, that the best and most intelligent and faithful service can always be obtained from the men who run them, or that fuel even approximating in quality to the best is always obtainable. Nevertheless, the results of the tests of Mr. Webb's, Mr. Buchanan's and Mr. Dean's locomotives show what degree of economy is attainable with existing locomotives. The data quoted shows that there is abundant room for improvement from better maintenance, better management and the use of good fuel, and that it cannot be assumed that modern locomotives have reached a maximum degree of efficiency or economy.

The attention, too, of locomotive superintendents is called to the remarkable figures in our table. Who can match them? and if the degree of economy attained by these engineers cannot be equaled on other roads, it would be a very pertinent inquiry to ask, Why not?

A noteworthy fact, too, is that both Mr. Buchanan's and Mr. Dean's simple engines were more economical than Mr. Webb's compound passenger locomotive, although the relative weight of train to that of the engine and tender was not quite so great with the simple machine as it was with the compound, but the speeds were higher. It would be opportune to challenge the advocates of compound locomotives in this country to give us some similar data with reference to their performance corresponding to that which is given in our table. In that it appears that trains more than twice as heavy as the engine and tender are hauled at speeds of over 50 miles per hour with a consumption of coal of a little over 2¼ oz. per ton of cars and contents per mile. If any compound engine in this country can beat this, it is desirable to know it. Who will give us a test similar to that which Mr. Webb has made, of one of our heavy freight engines? His simple engine burned a little over 1⅝ oz. per ton of train per mile, while his compound consumed only 1⅓ oz. Who in this country can match this either with simple or compound engines?

NEW PUBLICATIONS.

Index to Technical Journals.

The *Engineering Magazine* has added an annex to its different departments in which it reports the progress of the science and art to which it is devoted. These departments are Architecture and Building; Civil Engineering; Domestic Engineering; Electricity; Industrial Sociology; Marine Engineering; Mechanical Engineering; Mining and Metallurgy; Municipal Engineering; Railroading; Street Railways, and Scientific Miscellany. At the end of each of these departments an index to leading articles which have appeared in different publications during the preceding month is given, and which will be found useful by all who are interested in the subjects to which these articles relate. It is to be regretted, though, that the various efforts which are now being made to index current technical literature cannot be combined in some way. An index to the indexes will soon be needed.

Through Locomotive Works. *Being Advice to Young Mechanical Engineers.* By Randal W. McDonnell. Dublin: William McGee; London: Simpkin, Marshall, Hamilton, Kent & Co. 61 pp., 5 × 7½ in.

This little book, which can be read in a half hour or less, will carry those who have been through the shops back to the recollection of their early days, when it seemed to some of us that we had a hard road to travel. The advice and experience of the writer are interesting, but will not be of very great value to any who have to go over the road which he attempts to blaze. Unfortunately, we all find out the value of good advice when it is too late. In the present instance there is not much room for this bitter reflection, because the author does not give much advice, but contents himself by describing very briefly what his own experience in the shop was. It will give a reader an idea of what an apprentice in an English or Irish locomotive shop must encounter. At the present day, when government by trades unions and walking delegates is impending, there seems to be a dearth of the kind of literature which was intended to be a guide to apprentices. There is a superabundance of technical literature—such as it is—but it seems as though it would be wholesome to impress upon apprentices and mechanics at times the obligation of obeying the ten commandments, faithfulness to employers, and directions to those who have been without early advantages how to improve their minds. In none of these directions has the book before us much value.

Catalogue of the Exhibit of the Pennsylvania Railroad Company at the World's Columbian Exposition, under the Direction of Theodore N. Ely, Chief of Motive Power, and J. Elfreth Watkins, Special Agent in Charge of Exhibit. The Pennsylvania Railroad Company, Philadelphia. About 180 pp., 5¾ × 11½ in.

Mr. Ely's name is always a synonym of good taste, no matter whether it is attached to the design of a car, the furnishing of a room, or the typography and illustrations of a book. The volume before us is a confirmation of this observation. It is admirably printed, illustrated and arranged. The paper is of a heavy "coated" quality, which, besides having positive merits, has also the negative one of not smelling bad, which fault is often a cause of offense in that material.

In a preface it is said that "It is the purpose of the Exhibit not only to perpetuate the early history of the Pennsylvania Railroad Company and of the lines merged into or associated in interest with it, but also to place permanently upon record the results that have attended the efforts of the management to introduce those advanced methods in the art of transportation which have culminated in such a high degree of efficiency as to entitle the Pennsylvania to be known as 'the standard railroad of America.'"

In a circular enclosed with the volume it is also said that the exhibit described has been sent to the Field Columbian Museum, of Chicago, by the Pennsylvania Railroad Company, and is now installed in the museum building in Jackson Park, Chicago.

The book is elaborately illustrated, first with views of the beautiful building in which the Exhibit was housed during the Exposition, a map of the grounds, and some of the outdoor exhibits. It is to be regretted, though, that the engravings of the building were made on so small a scale. They are printed on a large page, which would have admitted of the illustrations being made of nearly twice the area they now are, in which form they would have been much more effective than they appear.

A review of a catalogue of this kind is almost a hopeless task. It is like reviewing a dictionary. The views referred to are followed by an excellent half-tone engraving of the celebrated *John Bull*, built for the Camden & Amboy Railroad, and its train, which has been illustrated so often. This is as large as the page will admit, and is excellent in every way. This is followed by some views of the cars for the large guns which were exhibited. Then there are drawings or views of cars, of models of an old Conestoga wagon and stage coach, canal boats, old locomotives, tug and ferry-boats, signals, bridges, and then a long list, which fills about one-quarter or a third of the book, of "relics" in frames and cases, on which we might descant to the extent of many pages. A series of excellent views of modern equipment locomotives and cars is also a feature. Again we wonder that the scale of these was not increased, for which there was abundant room. The book ends with a series of *fac-simile* engravings of old posters, way bills, tickets, etc.

There is no index though, which is the only serious fault we can find with the publication.

Centrifugal Pumps, *an Essay on their Construction and Operation, and some Account of the Origin and Development in this and other Countries.* By John Richards. San Francisco: The Industrial Publishing Company. 68 pp., 6¼ × 9¼ in.; $1.00.

Mr. Richards's book consists of the articles which were republished from *Industries*—the paper of which he is the editor—in recent numbers of the American Engineer. In these articles the author says he has dealt with the subject empirically, and in many cases has felt called upon to controvert assumed data. He says, further, that the principles of centrifugal pumps defy the mathematician, and for this reason there is little literature which has aided the makers of such pumps to any considerable extent. The author continues in his introduction to say that "formulæ, such as exist, are ignored by the practical pump-maker, who soon learns, to his cost sometimes, that computations will not supply proportions or define the working conditions required, and that he must proceed tentatively and tediously to ascertain the best forms of construction for particular uses, and for the head and pressure in each case." This latter quotation will give the keynote of the articles which form the book before us, the title of which should have been "Practical Notes on Centrifugal Pumps." It can hardly be regarded as a treatise on the subject, for the reason that it is not sufficiently comprehensive. Its general defect is that the author has assumed that his readers knew much more about centrifugal pumps than they do. It is always safe to assume, in beginning a book, that the persons who will read it know nothing about the subject of which it treats; and it is a fact that no matter how well acquainted with a subject a person is, he nearly always enjoys and, to a greater or lesser extent, is profited by reading clear, elementary expositions of it. The interest and profitableness of Mr. Richards's essay would have been much increased to many of his readers who, like his reviewer, are not experts in hydraulic engineering, if he had explained a little more fully in the beginning the principles on which centrifugal pumps work, and had described more fully general forms of construction. It should be said, though, in justice to the author, that this deficiency in his work is due to the ignorance of the general reader, which it is always safe to assume.

From the introductory page of the book to its end it is obvious, though, that it is the work of an expert in the subject of which it treats. In writing he has not taken the trouble often to explain the processes and reasons which have led him to reach his conclusions, but in a sort of discursive, conversational way he tells his readers the results of his experience, observation and reflection in dealing with the branch of engineering which he has written. There is a sort of machine shop flavor about what he has written which to many readers is much more stimulating than the speculative class-room style which is now so prevalent in much technical literature. Mr. Richards tells us what he has learned in building centrifugal pumps, and explains the difficulties he has encountered in making them work; and he does this in a very direct and clear way, which is not difficult to understand.

The first part of the book is on Constructive Features, and consists largely of practical observations with reference to their plan, forms and proportions. The second part is a History of Centrifugal Pumps, which we are inclined to believe might have been more fully elaborated, and many readers will heartily agree with what is said in a foot-note on page 35, that "it is to be regretted that notes of the various references consulted by the author in 1886 have been mislaid or destroyed, otherwise citations would have been given here. The search, mainly in serial literature of the time, was too long to be repeated."

The appendix consists of communications from engineers and makers of centrifugal pumping machinery on the Pacific coast, which will interest many readers. Altogether, Mr. Richards's essay may be described as a practical book by a practical man on a practical subject.

The Construction of the Modern Locomotive. By George Hughes, Assistant in the Chief Mechanical Engineer's Department, Lancashire & Yorkshire Railway. New York: Spon & Chamberlain. 261 pp., 5½ × 8¾ in. Price, $3.50.

Usually a reviewer can get at least some idea of the character and scope of a book from the title and the author's preface. In the present instance the title, "The *Construction* of Locomotives," and the statement in the preface that the design of locomotives has not been touched upon, as it does not come within the scope of the author's plan, gives a clew to the general purpose of the writer, who has divided his subject into three sections: The Boiler; The Foundry, and Forgings. The second of these treats of the Iron Foundry; The Use of Steel Castings; and the Brass Foundry. The third is on the Forge; Smithy, including Springs; Coppersmiths' Work; the Machine Shop and Erecting. The last two subjects, it would seem, should have been treated in a separate section.

That it should be impossible to treat the subject of "boiler construction" exhaustively in 36 pages of about 375 words on each is obvious. Twenty-seven pages are devoted to the Iron Foundry, 31 to the Brass Foundry, 56 to Forgings, nine to Coppersmiths' Work, 45 to the Machine Shop, and 23 to Erecting. Obviously the treatment of all these subjects must be and is superficial. Nevertheless, the author gives his readers much interesting and valuable information in a style which may be described as a kind of technical prattle. The book is written somewhat as some loquacious women talk. The author seems to be full of his subject, and has an immense amount of information which he proceeds to record in a discursive sort of way, without troubling himself to reduce it to any systematic order. Evidently he knows a great deal about his subject, but probably is more at home in a machine shop than at an author's desk. The book is full of hints and suggestions which will be interesting to the novice, and many of them to the veteran in locomotive building. The value of the book for the former would, however, have been much increased if the descriptions and explanations had been made more elementary and comprehensive, and to experienced mechanical engineers it would be more interesting if it had been made less elementary. As it was written it hardly seems to meet the wants of either class fully, although persons belonging to each can read it with interest and profit.

It is illustrated with over 300 outline engravings, most of them very poor "process" illustrations, for the badness of which there can be no adequate excuse in these days of cheap engraving. Some of the drawings, too, are hardly up to the standard to which the illustrations in such a book at the present day should conform. The one on page 14 is an example. Nearly all the illustrations are, however, made from original drawings, which merit will cover many sins.

The frontispiece is a folded plate printed from a wood-engraving, and represents a six-wheeled coupled "goods" engine designed Mr. John A. F. Aspinall, Chief Mechanical Engineer of the Lancashire & Yorkshire Railway. A sectional view of this engine is given in the chapter relating to Erecting, and other views showing it or its parts in successive stages of construction will give a student or apprentice a very good idea of the processes by which the parts of a locomotive are assembled and put together.

The chapter on Steel Castings is a new one in a book on the locomotive, and is demanded by the extended use which is now made of that kind of material. A list of parts which are made of steel castings on the locomotive referred to shows that their use is somewhat more extended in English practice than it is in this country.

The book may be read with interest and profit by any one who is engaged either theoretically or practically in the construction of locomotives, be he student, designer, apprentice, mechanic, or superintendent of motive power; but it belongs to that class of publications which makes the reviewer wonder why the author, having taken as much trouble and shown the ability he did to make the book as good as it is, did not devote more thought and work to it and make it a great deal better.

BOOKS RECEIVED.

PRACTICAL NOTES ON ROPE DRIVING. By M. E. Reprinted from the *Street Railway Journal.*

ANNUAL REPORT OF THE CHIEF OF THE BUREAU OF STEAM ENGINEERING. Washington: Government Printing Office.

AERIAL NAVIGATION. By A. F. Zahm. Johns Hopkins University (reprinted from the *Journal of the Franklin Institute*).

THE MEASUREMENT AND DIVISION OF WATER. Bulletin No. 27 of the Colorado State Agricultural College, Fort Collins, Col.

THE ELEMENTARY PRINCIPLES OF MECHANICS. VOLUME I, KINEMATICS. By A. Jay DuBois, C.E. New York: John Wiley & Sons.

REPORT OF THE CHICAGO STRIKE. By the United States Strike Commission Appointed by the President, July 26, 1894. Washington: Government Printing Office.

ACCURATE TABLES OF DIAMETERS, AREAS, WEIGHTS, ETC., OF COLD-DRAWN SEAMLESS TUBING. Calculated and Published by O. J. Edwards, Ellwood City, Pa.

A DISCUSSION OF THE PREVAILING THEORIES AND PRACTICES RELATING TO SEWAGE DISPOSAL. By Wynkoop Kiersted, C.E. New York: John Wiley & Sons.

ANNUAL REPORT OF THE CHIEF OF THE BUREAU OF CONSTRUCTION AND REPAIR to the Secretary of the Navy of the United States. Washington: Government Printing Office.

TRANSITION CURVES. A Field Book for Engineers, Containing Rules and Tables for Laying out Transition Curves. By Walter G. Fox, C.E. New York: D. Van Nostrand Company.

CENTRAL STATION BOOK-KEEPING AND SUGGESTED FORMS. With an Appendix for Street Railways. By Horatio A. Foster, C.E., Member American Institute. New York: The W. J. Johnston Company, Limited.

R. F. DOWNING & CO.'S NEW TARIFF OF UNITED STATES CUSTOMS DUTIES. Containing full copy of the Customs Tariff Act of 1894 and the Customs Administration Act of 1890. New York: R. F. Downing & Co.

CATECHISM OF CAR PAINTING. By Frederick S. Ball, Master Car Painter, Pennsylvania Railroad, Altoona, Pa. Reprinted from the Proceedings of the Master Car and Locomotive Painters' Association by the *Railroad Car Journal.* New York.

TRADE CATALOGUES.

MESSRS. BEAMEN & SMITH send us what they call their "Special Pamphlet No. 1," which is a little sixteen-page folder, illustrating and describing their horizontal spindle drilling and boring machine and its uses. The illustrations are outline drawings, and show very clearly the uses to which this machine may be put. The last page contains illustrations of milling machines made by this firm.

1895 ILLUSTRATED CATALOGUE AND PRICE-LIST OF THE LUNKENHEIMER COMPANY, *Manufacturers of Superior Brass and Iron Valves, Lubricators, and Steam Specialities.* Cincinnati, O. 107 pp., 6¼ × 9 in.

In this book the publishers give illustrations, descriptions, and lists of the various sizes and kinds of articles which they manufacture. These include, first, a great variety of gate, globe, check, throttle, and safety-valves, cocks, whistles, low-water alarms, water-gauges, and columns, steam-gauges, lubricators, oil injectors, etc. By actual count the book contains 185 engravings, which will be an indication of the variety of articles which this Company manufactures.

CUTTERS, Brown & Sharpe Manufacturing Company, Providence, R. I. 24 pp., 6 × 9 in.

This publication is devoted especially to the illustration of milling "cutters," which are made by this Company. In the preface it is said that "most of the illustrations are selected to suggest our facilities for special work." The engravings are half-tone work, and with the exception of one are nearly full size, and include an involute gear cutter, side milling cutter, several special forms of cutters, metal slitting saws, a large milling cutter, others with inserted teeth, and a gang of cutters. This illustrative pamphlet gives an idea of the great variety of work which is now done on milling machines, the use of which seems to be extending more and more each year.

MODERN METHODS OF HANDLING FUEL, *as Practised in Locomotive Coaling Stations, Electric Light, and Street Railway Power Plants.* The Link Belt Machinery Company, Chicago, Ill. 24 pp., 7¾ × 9 in.

The manufacturers have here given a series of half-tone engravings of 10 different coaling stations on railroads; then some views in boiler-rooms, coal pockets, conveyors, and other coal handling plant, etc. The last engraving represents a view in the boiler-room of Swift & Company, at the Union Stock Yards, Chicago, and shows a "Standard" water-tube boiler furnished by the Link Belt Machinery Company.

The illustrations are all very good, but would be more effective, it is thought, if they were printed in black instead of blue ink, as they are.

THE MAYDOLE HAMMERS. Manufactured from solid crucible cast steel by the David Maydole Hammer Company, Norwich, Chenango County, N. Y. 32 pp., 6 × 9¼ in.

This book is an illustration of how an art is evolved, as Herbert Spencer says, "from the homogeneous to the heterogeneous." It is an advance from the simple to the complex. A hammer would seem to be a very simple implement, and yet here we have such tools designed for a dozen different purposes, each kind with some special feature to meet the requirements for which it is used. There are nail hammers, hammers for farriers, horseshoers, blacksmiths, engineers, carriage ironers, machinists (four styles), coopers, tinners, riveting, boiler-makers, brick-layers, stone-cutters' and masons' hammers, all of which are represented by good engravings, printed in two tints.

ILLUSTRATED CATALOGUE OF BELL'S IMPROVED PATENT STEAM HAMMERS. By David Bell, Builder of Iron Ships, Iron and Steel Steam Yachts, Engines and Boilers, Improved Propeller Wheels. Buffalo, N. Y. 24 pp., 5 × 6 in.

The author in his catalogue gives us first a picture of himself, which makes us acquainted with him; opposite to this his publication contains a picture of his office and works. After these there is a description and very good wood-cuts of the steam hammers which he makes. These are of the variety which have a large piston-rod which acts as a guide to the hammer-head. Four sizes of these are illustrated, and a long list of names of firms and companies which are using these machines. Some views in the beautiful city of Buffalo, and also one of a lake ship and "Bell's speed propeller wheels," complete it.

THE THURMAN FUEL OIL BURNER COMPANY'S SYSTEM OF BURNING CRUDE PETROLEUM, *as a Substitute for Coal, Coke, and Wood for Boilers, Furnaces, Forges, Ovens, Driers, Brick-Kilns, Potteries, etc.* 36 pp., 6 × 9 in.

This pamphlet opens with advertisements of this device, which are followed by engravings showing a perspective view of the boiler plant at the Columbian Exhibition. Outline engravings and descriptions are then given, showing the application of the device to steam boilers, forges, kilns of various kinds, and a sand-drier. These descriptions are followed by testimonial letters, and the volume concludes with several articles in which the advantages of oil as a fuel are set forth. A small folded circular was also sent with the pamphlet describing the application of the burner to grates and other domestic purposes.

STEAM, HYDRAULIC, AND OTHER CRANES. Craig Ridgeway & Son, Coatesville, Pa. 40 pp., 6¼ × 9 in.

The manufacturers in this pamphlet illustrate and describe different kinds of their "Balanced Steam Hydraulic Cranes," which are a specialty of their manufacture. These are nearly all of the jib variety, which are operated by a vertical cylinder which is suspended alongside the center post opposite to the jib. The piston is stationary, and is attached at its lower end by a jointed connection to a tank or reservoir partly filled with water. The power is obtained by admitting steam to the top of this tank above the surface of the water, which is protected by a baffle-plate or float, so that the steam does not come in contact directly with the water. The pressure on the water produced by the steam is communicated to the cylinder and piston, through the action of which the crane is operated. Cranes for a variety of purposes, such as foundries, blast furnaces, rolling mills, etc., are shown. The Company also

manufacture air-hoists, of which they illustrate a variety adapted for different purposes. The illustrations are wood engravings and outline "process" reproductions, and show the different forms of cranes to very good advantage.

Howden Hot-Draft System. *Its Economy, as Compared with Natural Draft.* 16 pp., 5¼ × 6½ in.

Performance of the Steel Steamer. *Harvey H. Brown.* The Detroit Dry Dock Company Detroit, Mich. 21 pp., 5¼ × 6½ in.

The first of these pamphlets gives a description of the construction of the Howden hot-draft system for marine boilers and a statement of its advantages, and gives engravings which represent sectional views of a boiler, with this appliance. These are printed in red ink, which, it is thought, detracts somewhat from their clearness. The construction is explained, and a history is given of the development of this invention, which has been extensively applied to steamers in Europe.

The second pamphlet gives a report of an experimental test of a round trip of the steamer *Harvey H. Brown*, which was made in the lakes while carrying iron ore from Lake Superior ports to Lake Erie ports. The tests were conducted and reported by George C. Shepard, of Cleveland, O. The dimensions of the ship are given, a synopsis of log, indicator diagrams and data, and general results of the test. The Detroit Dry Dock Company are the sole owners and manufacturers of the Howden hot-draft system for the lakes.

The Johnson Railroad Signal Company, Rahway, N. J., *Reference Book of Parts in Connection with Interlocking and Block Signaling.* 241 pp., 4¾ × 7 in.

In the preface to this book the Johnson Company say: "We have purposely limited its scope to the extent of dealing only with detail parts, in order to facilitate the ordering of a complete device or any part thereof.

"It is our intention to issue a new general catalogue, having reference more especially to the science and art of railroad signaling, and showing by diagram and explanation what we consider the best practice in connection with the various branches of the art."

The book is beautifully printed, and bound in limp morocco covers with round corners. The frontispiece shows a view of the works at Rahway, and on the next page is a view of the exhibit of the Company at Chicago, and on page 5 is a view of the Johnson No. 1 interlocking machine. Most of the engravings which follow these—and there are a great many of them—are outline views of details of signal apparatus, although there are some half-tone views made from photographs. As the publishers say, "All the devices illustrated are numbered in order that they may be unmistakably referred to, by naming the page on which the device is shown and its number."

It is an admirable specimen of a catalogue of this kind, is of convenient size, and is all in the very best taste excepting a few errata noted in a slip at the beginning of the volume.

It is copyrighted, and the publishers have adopted the excellent plan of offering it for sale to the general public at the price of $3.

Catalogue of Apparatus, *Manufactured and Sold by the Sperry Electric Company.* Cleveland, O. 28 pp., 6 × 9 in.

This admirably printed and beautifully illustrated catalogue is another illustration of the truth of the remark of Herbert Spencer, that "of constructive imagination, as displayed in good exposition, men at large appear to be almost devoid." The Sperry Company have illustrated their motors for electrical cars with beautiful half-tone engravings made from photographs, and have said a great deal about the merits of their system, but have not described it so that any one who has no knowledge of it can understand it. The further observation of Spencer that "good exposition implies much constructive imagination. A prerequisite is the forming of true ideas of the mental states of those who are to be taught; and a further prerequisite is the imagining of methods by which, beginning with conceptions they possess, there may be built up in their minds the conception they do not possess." The author of the pamphlet before us obviously has little of this "constructive imagination," and one wanders through the pages vainly in the effort to understand the mechanism which it is there attempted to describe. The engravings are excellent. The one opposite page 5 is faithful to the minutest detail, even to representing the policeman on the rear platform, who looks as though he might be a subject for investigation by the Lexow Committee; but there is nothing in this picture and little in any others which helps us to understand how these cars are propelled. The same thing may be said of the description of the electric brake in the back part of the publication. The brake is highly commended, but the reader who is ignorant of its construction, who can understand it from the description given, must be a very astute person, and have more "constructive imagination" than most readers have.

Reference Catalogue (No. 2), Giving Detailed Plans, Illustrations and Descriptive List of Interlocking and Signaling Apparatus, Manufactured by the National Switch & Signal Company, Easton, Pa. 154 pp., 7¼ × 10 in.

A reviewer of trade catalogues is compelled at times to wonder where luxurious typography, paper, binding, and engraving will end. The volume before us, with the exception of the cover, is not showy, and yet everything in it is of the very best, and seems exactly suited to its purpose. The cover is of limp morocco stamped with a specially designed title of the company, with two semaphores, one in the safety and the other in the danger position. The frontispiece is a good half-tone engraving of the works, which is followed by the same kind of an illustration of their interlocking machine. In the preface it is said that this "catalogue" includes "such plans, details and descriptions as appertain more directly to that branch of the art generally called mechanical work; and while a few half-tone pictures of electrical devices are shown, the details and further illustration are reserved for a future edition."

The principal portion of the book is devoted to the illustration and description of the details of different parts of signals and gives the numbers by which they are designated. The system of numbering is a modification of the Dewey system which is explained. The engravings are shown in white lines on a blue ground, and represent blue prints very closely. They are all admirable examples of clear, neat drawings, with nothing superfluous, and yet they show everything that is required to be shown. In some few cases the reduction of the drawings has been so great that definiteness of the engravings has been lost, but that is only in a very few instances, as on page 92.

The last part of the book contains half-tone engravings of a two-arm dwarf signal, the National Company's double wire compensator, a torpedo signal, several illustrations of an electric slot and semaphore, the National block signal and its motor. A view on the line of the Central Railroad of New Jersey, showing one of the automatic semaphores in advance of a cut and curve with the signal cabin, and a good index complete this admirable publication.

NOTES AND NEWS.

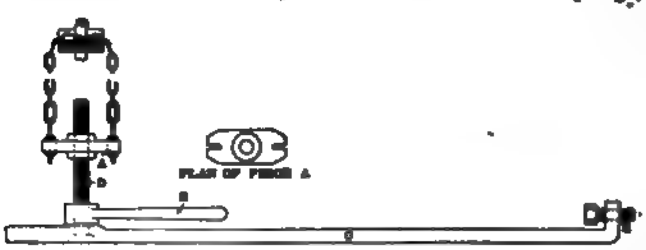
The Three New Torpedo Boats.—The three new boats of this class which were authorized by the Naval Appropriation Bill will, it is said, in general plan follow the design of the *Ericsson*, and have a speed of about 24½ knots. This will fall far short of the speed of the new Yarrow and Thorneycroft boats, or even of those of Schichau and Normand. The reason for this, it is said, is that the appropriations and the dimensions to which the boats are limited will not admit of as high a speed as has been attained by some of the most recent foreign boats. The *Hornet*, it will be remembered, reached a speed exceeding 28 knots as a maximum; and the *Daring*, another Thorneycroft boat, reached the striking speed of 29.268 knots for a single knot. The *Adler*, built by Schichau, of Elbing, for Russia, reached the great average of 27.4 knots. A couple of Yarrow boats built for Italy reached a speed of 25.1 and 24.96 knots respectively. The *Forban*—now building by Normand, of Cherbourg—is said to have a designed speed of 30 knots; and an aluminum torpedo-boat is spoken of which it is expected will have the astonishing speed of 31 knots. In the mean while, much doubt is expressed with reference to the actual value of torpedo-boats in naval warfare.

Oil Burning on the Austrian State Railway.—The *Zeitung des Vereins* publishes the following report regarding some tests of oil burning which have recently been made on the Austrian State Railway. Excellent results have been obtained from these tests, and they show that it is possible to obtain complete combustion without any smoke by using injectors which throw the liquid fuel over the lighted coal in such a way that mixed with the quantity of air necessary, the combustion is complete. The liquid fuel, which is the residue of the petroleum, is placed in the tank of the tender, and which

in winter time is heated to prevent coagulation. The action of the oil is so energetic that the steam pressure of a locomotive heated in this way can be raised in three minutes from three to ten atmospheres, while with coal alone 6¼ minutes are required. On long runs the steam pressure can be kept at maximum pressure, while the engineer has absolute control of the fire, which he can check or increase in intensity as production of steam may require. This method is to be applied to the engines of the Metropolitan Railway of Vienna. It is a system designed by Mr. Holden of the Great Eastern Railway of England, which has been described in previous issues of this paper.

Superheated Steam.—The economical advantages of superheated steam are claimed to be exhibited in a remarkable degree by the Serpollet motor, lengthy accounts of which have appeared in the foreign papers. This motor is described as having a single horizontal cylinder of $5\frac{1}{16}$ in. in diameter and stroke; the cut-off was fixed at 66 per cent. of the stroke, the admission pressure was 58 lbs. per square inch, and the revolutions 284 per minute. The brake H.P. on a four hours' trial averaged 4.57 H.P., and the steam consumption was but 29.87 lbs. per brake H.P. an hour. The advantage thus indicated is credited to the boiler, which supplies superheated steam; this boiler consisting of a stout tube flattened so as to deform the passage through into a narrow slit. The tube is coiled, and has one end connected with a feed pump and the other with the engine to be driven. The boiler used in these tests had a heating surface of nearly 27 sq. ft., and the grate area was nearly 3 sq. ft. The steam, though showing on the gauge a pressure of 58 lbs. per square inch only, had a temperature of 1,009° F. on issuing from the coil, which had fallen to 572° at the steam-chest; the temperature of saturated steam at 58 lbs. pressure is about 306°, so, as used in the engine, was superheated by some 266°. The output of steam was 4.9 lbs. per square foot of heating surface per hour; the fuel used was briquettes having a heating power of 8.26 lbs. of water, 212° per pound of fuel.

Device for Removing Driving Springs.—A little device which we illustrate herewith, is one that is in use in the Middletown shops of the New York, Onario & Western Railway, for removing driving springs. It consists of a bar, *C*, turned up at one end, and provided with a set screw, *B*; this bar is intended to have one end slipped under the head of the rail and the other to be held by the set screw *B*, the end coming under the other rail head directly beneath the location of the springs.



The screw *D* is placed with its head bearing in a socket on the bottom from the main bar; this screw is turned by a ratchet, and *E A* is a nut of the shape shown; it is run up on the thread of the screw, and the chain laid over the spring and caught in the notches *A* as shown; the screw is then turned and drawn down until the chain tightens and the spring compressed sufficiently for the removal of the keys. It is a home-made affair, but very handy for round-house work.

A Tank on a Smokestack.—A novel use of a smokestack has been made at a French industrial establishment. Where an elevated tank was desired for storage of water and to give pressure, the main smokestack of the works was utilized as a pedestal, and the tank was thus elevated 75 ft. above the ground at a minimum expense. The tank is annular in form, the inner and outer walls being concentric with the chimney and a little distance removed from it. The tank is supported on a stone sill ring built into a brick corbel on the chimney, and is held by radial angle-iron struts. Ladders pass between the tank and the chimney and down into the tank, which has the customary supply, discharge and overflow pipes. An umbrella-shaped sheet-iron roof covers the tank and probably has orifices to permit a circulation of air in summer and prevent it in winter, as it is stated that the annular air space prevents any appreciable warming of the water from the hot gases in the chimney, while sufficient heat is received to prevent freezing in winter. The volume of the reservoir is about 3,532 cub. ft., its weight, empty, 11 tons, and 123 tons when full. No statement is made concerning the location of this chimney, but it would appear that where foundations are easy and ample such a utilization of a smokestack for a tank pedestal might prove convenient and economical if the construction were not too unsightly, and if sufficient stiffness or ample guying against the possible great wind strains is provided.

Armor Plate Tests at Bethlehem.—Another successful test of the Bethlehem Iron Company's armor plate was made early in October at the company's proving ground. The plate tried was one representing 300 tons of armor for the battleship *Texas*, and all were accepted by the Government officials. The plate is 12 in. thick at the bottom and tapers to 6 in. at the top. It is 18 ft. long and 6¼ ft. wide, Harveyized, and weighs 50,000 lbs. Two shots were fired at it from an 8-in. gun. The point of impact of the first shot was 6 ft. 6 in. from one side and 34 in. from the bottom of the plate. A 250-lb. Holtzer projectile was shot at the plate with a charge of 79½ lbs. of hexagonal powder, at a velocity of 1,678 ft. per second. The projectile was badly upset, and a portion of it remained in the plate, making it difficult to determine the penetration, but the Government officers estimated it at 6 in. In the second shot 110 lbs. of powder were used, and the same weight and kind of projectile. The velocity was 2,004 ft. per second. The point of impact was 40 in. from the side and 31½ in. from the top. The result was almost the same as that of the first shot. The shell was smashed, and a large part remained imbedded in the plate. The penetration was estimated at 8 in. Neither of the shots caused any bulging of the plate, and there was no disturbance of the backing or springing of the bolts that held the plate fast to the large timbers. The plate fired at was selected for the test because it was believed to be the poorest in the lot.

A Light Experimental Railroad.—The London *Times* recently published the following account of a light, narrow-gauge railroad with which a gentleman in England has, apparently, been amusing himself for some time past. Of this road it is said:

"Mr. A. Percival Heywood, son of Sir Percival Heywood, having lately added largely to the rolling stock and capabilities of his light railway of 15 in. gauge, invited recently a number of friends and others interested in cheap transport to inspect the working of the line at Duffield Bank, near Derby. Two small locomotives, coupled all round, with flexible wheel base and other improvements, were shown in steam, and closed and open bogie carriages conveyed visitors over the line, half a mile of which was arranged to admit of continuous runs. Dining and sleeping cars, together with goods wagons, vans, etc., conveying various loads, were shown at work. A dynamometer car, fitted with instruments to indicate the power and speed of the engines, was also exhibited. The visitors inspected the amateur workshops and foundry adjoining, where the locomotives and rolling stock were constructed.

"The primary object of the exhibition was to solve the various problems involved in the successful designing of engines, carriages and roadway of the narrow gauge. The chief ends in view were, first, the application of narrow-gauge lines to agricultural and commercial purposes, and, secondly, to the requirements of military transport in countries destitute of roads. The latter point some years ago engaged the attention of the Royal Engineers.

"The construction of this line of 15-in. gauge was begun in 1874, and various additions were made up to 1881, when the length laid amounted to about a mile, inclusive of sidings. Since the latter date there has been no material extension, but the permanent way and its accessories have been improved. The line runs from the farm and workshops up a gradient, varying from 1 in 10 to 1 in 12, about ¼ mile long, to a level 80 ft. above, where the experimental course is laid out in the shape of a figure 8, so as to admit of continuous runs. This part, somewhat more than ½ mile in length, has a level stretch of ¼ mile, the remainder consisting of gradients of which 1 in 25 is the most severe. The maximum curve on the main line is of 25 ft. radius, but in the sidings some occur which are as sharp as 15 ft. radius. The permanent way was at first laid with 14-lb. rails, without fishplates, spiked to elm or Spanish chestnut sleepers, felled and sawn on the premises. The line is properly equipped with interlocked signals and points on a very simple plan. There are on the railway three tunnels, two bridges, and a viaduct 90 ft. in length and 20 ft. high. The latter was built in 1878 as an improvement upon a very rickety one erected by Mr. Fell at Aldershot, when he induced the War Office to sanction an experimental line for army transport purposes. In addition to a number of wagons, some of which are fitted with brakes, there are on the line seven bogie passenger cars and a bogie van, as well as a variety of miscellaneous stock such as workmen's cars, screw and roller

rail benders, and dynamometer car. Mr. Heywood has also built a dining car and a sleeping car of the same dimensions as the cars already described.

"With regard to the locomotives themselves, they are probably, for their weight, the most powerful and flexible ever built to work by simple adhesion. It appears that the officers of the Royal Engineers have been trying the engine with a view to adopting the plan on the military railway at Chatham. They subjected it to very severe tests, loading it up steep inclines to its utmost capacity, stopping it with the steam brake almost dead when traveling at various speeds, and over the most awkward places, and finally giving it a 50-mile run with all the load that could be got together at an average speed of 7½ miles an hour, stops being made for water, etc., for 12 minutes in each hour. This was followed shortly afterward by a continuous run with a similar load for 1 hour and 85 minutes, the extreme limit to which the water in the tanks would hold out. There was no heating of any part during the trials, nor failure of any kind. After 8 years' work, chiefly on gradients of 1 in 10 to 1 in 12, where sand has to be used freely, the engine came into the shops to be overhauled. During this time there had been no mishap or breakage whatever, nor had a wheel ever left the rails except on one occasion."

This description has called out considerable correspondence and discussion of the subject of light railroads, and has elicited a letter from the engineer of a light railway, of which, apparently, little is known. The following quotation is from this letter:

"Incidentally, I have been somewhat surprised that no allusion has hitherto been made to the Swansea & Mumbles Railway (for which I am engineer), authorized by special act in 1804—one of the oldest and, I believe, most successful railways of this description in the kingdom, and fulfilling all the essential principles advocated by your correspondents, carrying a very large traffic, chiefly in passengers, but much general goods also. I venture to think this railway worthy of considerable attention, as showing what has and can be done in this direction in this country.

"I entirely agree that such railways in many rural and other parts of the country, connected at stations with the existing railways, are most desirable and the right thing, and in this opinion the late Mr. Grierson, one of the most capable railway managers of his day, entirely concurred; but I wholly disagree that they should be made of a different gauge, or that there would be any real economy in such light permanent way as it seems most of your correspondents contemplate. The reasons for this are obvious, but to explain them in detail would be too great a tax on your space. S. W. YOCKNEY.

"46 Queen Anne's Gate, Westminster, S. W., August 31."

Compound Locomotives on the Northwestern Railway of Switzerland.—The Northwestern Railway of Switzerland has had a number of simple and compound locomotives built by the Winterthur shops; they are identical in all parts, with the exception that in the compound engines the high-pressure cylinder on the left side, which is 15¾ in. in diameter, is replaced by a cylinder 22¾ in. in diameter, taking steam from the right-hand cylinder by way of a pipe passing through the smoke-box. To facilitate the starting, an inner starting valve is used, which allows live steam to be admitted directly into the large cylinder when the throttle valve is opened. The object of this identity in the construction of the engines is to permit of comparative tests being made of the consumption of fuel, which have been carried on for about nine months, starting in August, 1893, and extending through to April, 1894. For this purpose two types of engines were successively detailed to haul the trains for the same number of trips. Furthermore, the engine crews were transferred alternately from one to the other. In a word, the conditions of running were kept rigorously the same throughout the whole of this period. The average monthly run to each engine was 2,625 miles, with an average train load of 21.17, axles loaded to five tons each. The consumption of coal has been taken from month to month, and has resulted in showing a gain of from 15 to 16 per cent. in favor of the compound locomotive. Under these circumstances the company has decided to extend the use of these engines over its system, and has ordered six new ones from the Winterthur shops.—*Schwerzerische Bauzeitung.*

Life on an Iron-Clad at Sea.—Admiral von Werner, a high authority in naval matters in Germany, describes in a work recently published the behavior of armor-plated men-of-war in a heavy sea. He says: "Even with a moderate gale and sea, an armor-plated cruiser, if going against the wind, will find herself in conditions similar to those of a storm—at least the crew will have that impression. The movements of the stern of the ship are violent and exceedingly disagreeable. The waves, pushed by the advancing prow, sweep continually over the ship from bow to stern. All windows and portholes must be closed, and air reaches the lower decks, where the heat increases unbearably, only through the artificial ventilators. With the exception of the specially protected command bridge, all the uncovered portions of the ship are impassable; thus the whole crew must bear as well as they can the hell of the closed decks. On such a ship no one can feel comfortable; and when there is a storm in which a sailing ship would feel comparatively at ease, the crew of an armor-plated ship imagines itself to be in a heavy hurricane which threatens destruction at every minute. The long, narrow forepart of the ship, which is not borne lightly by the water, and is rendered extremely heavy by the mighty ram and the armored deck and the cannon and torpedoes, forces the ship in a high sea to pitchings and rollings of such an extraordinary kind that they cannot be described. The crew of such a ship is not only exposed to mortal dangers, but the voyages they make render them physically extremely and dangerously nervous; the mental impressions they receive wear them out and make the profession hateful."—*St. James's Gazette.*

The Effect of Firing Two Big Guns at Once.—The effects of two 10-in. turret guns being fired simultaneously are rather astonishing. A correspondent who was on one of the vessels taking part in the manœuvres graphically describes the effect of the concussion. He was leaning close to the turret, and while thus occupied the guns were fired. "For several moments," he says, "I wondered what hit me and where I was hit. I had been regularly lifted by the concussion, but came down quite whole." The glass that protects the helmsman from the weather and the windows in the chart house, the glass of which is ¼ in. thick, were smashed to atoms. An ink-bottle that stood on the table in the chart house jumped about 6 in., and every drop of ink sprang out, but the bottle dropped back to the spot from which it jumped. Three water bottles and three tumblers were on the table in the smoking-room, both being full of water. When the guns were fired the bottles and the tumblers jumped into the air. Three gentlemen who were in the room also left their seats. The bottles and tumblers fell back into their old places, but every drop of water had been spilled upon the table, though nothing had been broken. The doctor was about to extract a tooth from a patient, and had just got the forceps in the right place and taken a firm hold when the double explosion occurred. Both he and the patient were lifted, and when they came down again the tooth was out. The doctor said he had not pulled, and the patient said he had not felt the tooth coming out. And in one of the cabins the bath-tub had been jarred off two of the three hooks by which it was fastened to the ceiling, and was hanging by one hook.—*English Court Journal.*

Machine Work of the Bethlehem Iron Company.—An officer from the Navy Department, in speaking of the work which has been done for the Navy Department by the Bethlehem Iron Company, referred to the shafts of the *Raleigh* and *Cincinnati*, and said that when they were delivered to the Navy Yard it was found necessary to put them in the lathe in order to do some special fitting on them which had not been called for in the specifications given to the Bethlehem Company. In order to do this, plugs were turned up and driven into the hollow shafting, and these latter were found to be perfectly straight, 6 in. in diameter through a 18-in. shaft, and the testing of them with calipers from end to end could detect no variation in the diameters; and when they were finally swung in the lathes on these plugs they ran as true as though they had been on their original centers. The template which was made for the thrust bearing for one of these shafts was found to fit so accurately on the thrust bearings of the other three, two being used for each ship, that on only two of the collars of the whole four could the faintest glimmer of light be seen when the template was in position. Everything was polished and given a smooth water finish, as fine as that put upon the finest and smallest of work. When the eccentrics were to be bored out, it was found that one template was insufficient for boring out all of the eccentrics for all of the engines, the shafts being so accurately turned that any eccentric could be used in any position. When we take into consideration the size of the work done and the accuracy, it certainly speaks well not only for American mechanism, but also for the care and accuracy of the work done by the Bethlehem Company.

Ownership of Railroads.—The Interstate Commerce Commission has recently compiled some interesting statistics regarding the ownership of railroads by foreign governments, which may be summarized as follows:

"It appears that 10 countries do not own or operate rail-

ways—viz., Colombia, Great Britain and Ireland, Mexico, Paraguay, Peru, Spain, Switzerland, Turkey, United States and Uruguay. The following governments own and operate some of the railways: Argentina, Australasia, Austria-Hungary, Belgium, Brazil, Canada, Cape of Good Hope, Chile, Denmark, France, Germany, Guatemala, India, Japan, Norway, Portugal, Russia and Sweden—18. The following governments own part of their railways, but do not operate any, leasing all the present mileage to private companies—viz., Greece, Holland and Italy. Though not claimed to be accurate, it is believed that the foregoing summary represents an approximately correct statement of the relation of the various governments to the railways of the world. The relative rates charged for freight and passenger service on the government-owned railroads, and the facts cited in connection with such roads, are calculated to afford little encouragement to the advocates of government ownership. A comparison of passenger charges per mile shows an average in Great Britain of 4.42 cents for first-class, 3.20 cents for second-class and 1.94 cents for third-class. In France the average is 3.86 cents for first-class, 2.86 cents for second-class and 2.08 cents for third-class. In Germany the rate is 3.10 cents for first-class, 2.32 cents for second-class and 1.54 cents for third-class. In the United States the average charge is 2.12 cents a mile. The average charges for freight per ton per mile are as follows: In Great Britain, 2.80 cents; in France, 2.20 cents; in Germany, 1.64 cents; and in the United States, 1 cent. The interest on capital invested in the several countries is as follows: United Kingdom, 4.1 per cent; France, 3.8 per cent.; Germany, 5.1 per cent.; Russia, 5.3 per cent.; Austria, 3.1 per cent; Belgium, 4.6 per cent; United States, 3.1 per cent."

A Trans-Jersey Ship Canal.—At a recent meeting of the Trans-Jersey Ship Canal Commission, held in Philadelphia, it was decided to adopt the report of Lewis M. Haupt, Engineer-in-Charge, and put parties in the field at once to survey two proposed routes. In his report Mr. Haupt found it would be commercially unprofitable to build a canal which it is proposed to extend from Philadelphia to Raritan Bay at tide-water, as there is a general elevation of 100 ft. He suggests two 25-ft. lift locks. The Delaware & Raritan rivers were said to be the only available sources of supply. The two routes suggested both start from Bordentown. One goes through the Raritan River and Bay and the other reaches the sea by way of Monmouth Junction and Raritan Bay. The first has railroad crossings and a surface 52 ft. above the sea level, and the second has no railroad crossing, but would encounter ground 90 ft. above sea level.

French Doctors on Bicycling.—The French Academy of Medicine has recently discussed the healthfulness of bicycle riding and unanimously adopted the following resolution: "That the use of the bicyclette should only be permitted after a serious medical examination of the would-be rider." One of the Paris evening papers sums this resolution up by the remark: "One louis a visit, if you please."

Conundrum.—A correspondent who signs himself "Conductor" propounded the following recently in the New York *Sun*: "In relaying a portion of the track of the Erie Railway three men are bringing in a rail that is 30 ft. long. One takes hold of the end, the other two have a short wooden bar to place under the rail to assist in its carriage. At what distance from the opposite end to where the single man is placed must the two men be in order that each of the three men may bear exactly the same weight?"

Long-Distance Electricity.—It is proposed to supply San Francisco with electric power brought from Clear Lake, 75 miles distant, at which point it is estimated that 30,000 H.P. is available.

The New Navy Yard at Algiers.—Steps have just been taken for the purchase of additional land for the new naval station at Algiers, on the Mississippi, opposite the lower part of New Orleans. The establishment of a dry dock and a navy yard at this point has been under consideration for many years. A commission was appointed under Secretary Whitney, which reported:

"After carefully weighing all the advantages and disadvantages of Algiers as a site for a naval station, the commission is of the opinion that, while the spot is not an ideal one, no other place in the Gulf compares with it in the advantages offered, and that the advantages are so many and so great, and outweigh the disadvantages to such an extent, that the Commission has no hesitation in recommending the location of the Navy Yard and dry dock at the present Government reservation at Algiers."

This report, however, did not finally settle the question; and a second commission was afterward appointed. In general this commission concluded:

"That the site ought to have a deep-water frontage, so as to accommodate ships of the deepest draft. It was considered a further advantage that it should be far enough up some stream to have fresh water, so that the steel ships laid up at its docks would not deteriorate. It must be capable of defense from attacks, either by sea or by land, and would be all the better for being landlocked. It required facilities for inland transportation, with plenty of labor at hand and available, and it should be in a healthy locality."

In its report the commission mentioned as primary requisites for the dry dock, "a clear channel to the sea at least 26 ft. deep, stability of foundation to support a load of 15,000 tons, and protection, either by a distance of 12 miles or by an intervening elevation of ground, from gun fire from the sea." With all other things equal, proximity to a center of commercial and naval interest was held to be a determining element in the selection of a site. Taking these points together, it becomes clear why this second commission affirmed the choice of its predecessor; and if Congress makes the needed provisions for carrying out the plan the plan will be carried forward.

Rolling Stock of the Antwerp Exposition.—At the Antwerp Exhibition there were on view some very interesting specimens of modern rolling-stock. A six-wheeled corridor coach of the Paris & Lyons Company, showing all the finish and careful attention to detail that usually marks French railway carriage building, took my fancy particularly. These were two points which I only wish our English companies would imitate in their sleeping cars, dining cars and other similar vehicles. Most people who have traveled much in this country in sleeping cars in cold weather have known what it is to find their heads next the outside air, with nothing but a thin sheet of glass and a thin blind to protect them, and to have to put their heads under the bed clothes to avoid being frozen, or, what is even worse, waking up with toothache. The Paris & Lyons sleeping-coupés had shutters, hard wood toward the outside, but padded with cloth on the inside to keep the cold out. Again, most of us have known what it is to sit in a dining car destitute of ventilation except by means of a window opening upward just at the height of the tables, which in the first place peppered the soup with blacks from the engine, and in the second place tended to give all but the most robust passengers a bad attack of lumbago. In the Paris & Lyons carriage the upper 6 in. of the large fixed windows were made to open with a sash that slid upward out of sight into the top framing of the coach.

But corridor carriages were by no means confined to the Antwerp Exhibition. Everywhere on the Continent they are coming into use for long-distance express traffic. In Hungary they seem to run almost nothing else, and alike in Austria and South Germany, in Prussia and in Belgium one found them on the important trains. The continental carriage-builders, less conservative than our own home companies, have not hesitated to abolish altogether, in the case of these carriages, side doors and the footboards along the outside as well. The consequence of course is that they are able to give much more room internally than we can afford. No doubt the blocking the gangways at important stations, when numbers of people wish to get in and out, is a considerable objection to the abolition of side doors. But in practice this disadvantage can be reduced to a minimum if guards and platform inspectors will take the trouble to see that no new passenger gets in until the last of the arriving passengers has had time to get out. There is, however, one point in connection with this blocking of gangways of considerable interest. Our American cousins often reproach us with the amount of luggage we take with us into the carriage, but there can be no doubt that continental travelers are in most countries greater sinners in this respect than we are. Nowhere is more than 66 lbs. of luggage allowed free; while no free baggage at all is the rule in all important countries except France and Prussia. Moreover, the tendency among continental railway officials is at present in the direction of greater restrictions, so that the circular tickets with which half the passengers in summer are supplied allow, even in Prussia, no free luggage. Add to all this the intolerable delays caused by the red-tape arrangements for registering and re-delivering baggage, and the reason why the gangways of continental trains are blocked not merely with hand bags, but with Gladstones and portmanteaus becomes sufficiently obvious. Before long some more stringent regulations will evidently need to be made in the interest of the passengers at large. Continental railway writers frequently describe the inclusion of an allowance of free luggage in the price of a ticket as a concession to the rich people who have luggage at the expense of the poor who have none to take. As far as my ex-

SCENES ON THE GREAT SIBERIAN RAILROAD DURING CONSTRUCTION.

perience goes, the truer formula would assert that the abolition of free luggage means the curtailment of the reasonable comfort of a large number of passengers in order to afford room in the carriage for the heavy baggage of a small number of selfish and callous fellow-travelers.—*Transport.*

PROGRESS IN CONSTRUCTION OF THE GREAT SIBERIAN RAILROAD.

The Great Siberian Railroad, commenced at its eastern terminus, Vladivostok, in 1891, and at its western terminus, Chelabinsk, in 1892, is now well in progress.

Besides the main line from Chelabinsk to Vladivostok it was decided at the sixteenth session of the Committee of the Siberian Railroad* to build a branch, connecting the Siberian Railroad with the existing Oural Railroad (Perm-Ekaterinbourg-Tumen). From different locations proposed for this branch, the western location—Ekaterinbourg-Chelabinsk—was chosen, which answered best to the needs and interests of many mining works of Oural. This branch was commenced in 1894, and will be completed in 1896, together with the Western Siberian Railroad, the chief engineer of which is Mr. Mikhailovski, who is also charged with its construction. The credit obtained for the construction of this line (without rolling stock) is 6,475,258 roubles.

Before giving data concerning the progress in construction of different lines composing the Great Siberian Railroad, I will explain the new plan of the whole construction proposed by the Minister of Finance in the seventeenth session of the Committee of the Siberian Railroad (May 3–15, 1894).

According to this proposition, the Central Siberian Railroad to Irkoutsk can be completed in 1898 (2 years earlier than was supposed); and the whole Oussouri Line—viz., South Oussouri from Vladivostok to Grafska, and North Oussouri, from Grafska to Khabarovka—can be completed in 1896. In consequence of it the committee decided to hasten the surveys of the Baikal and the Amour Lines, and the construction of the remaining lines in order (1) that in 1898 not only the Siberian Railroad can be carried from its western terminus (Chelabinsk) to Irkoutsk, but that the branch from Irkoutsk to Listvinichnaia Harbor on the Baikal Lake will be ready; and the Trans-Baikal Line can be completed; and (2) that the construction of the Amour Line be finished in 1901.

In the same session the Minister of Ways and Communications asked for credits for the surveys and the location of the Baikal and Amour lines, and for the beginning of works on the Trans-Baikal Line.

Having deliberated on the whole subject, the committee has decided:

1. To approve of the beginning of construction of the Trans-Baikal Line in 1894, and to use for this purpose at present two locomotives, 60 wagons, and rails for 100 versts of line, taking them from the stock prepared for other Siberian lines.
2. To approve the surveys of the Amour and Baikal Line.
3. And to assign for these surveys credits of 1,000,000 roubles for the former and 250,000 roubles for the latter.

After these general remarks I will proceed to the progress of works on every line.

The Western Siberian Railroad, from Chelabinsk to the Obi River (884 miles long) was begun in 1892, and will be completed in 1896. On its western side the track was laid to Kourhan (160 miles) in October, 1893, and the construction trains have been running from Chelabinsk to this city from October 4, 1893. In the winter of 1893–94 the traffic was opened also for local goods. The earthwork is here typical of the whole Western Siberia; it is performed chiefly by means of hand-barrows (litters), and when the distance is too great, by means of horse-barrows (two or four-wheelers). The Tobol iron bridge (1,400 ft. long; 4 spans of 350 ft., with semiparabolic girders) is now in course of construction, and a temporary timber bridge with loop line was built in order not to break off the track-laying. The illustration (fig. 1) shows this temporary bridge, the Tobol River, the loop line, the provisional water supply (by means of Körting's pulsometer), a general view of Kourhan city, and the store yard of materials for the construction of the permanent bridge.

The foundations of Tobol bridge are designed to rest on caissons, and for four spans five caissons are required. Their depth is from 50 ft. to 60 ft., and the sinking of one caisson requires from 4 to 6 weeks. The sinking of the first caisson was begun December 17, 1893, and the last (the fifth) caisson is now (August, 1894) already sunk. For the work two 25-H.P. engines and two old Vulcan air compressors are used. The removal of earth is performed by means of sacks hoisted by endless wire moved by means of a small 6-H.P. engine.

The annexed illustrations (figs. 2, 3 and 4) show the works of construction of the Tobol bridge—viz.: Fig. 2 shows the pile-driving for false works, fig. 3 the sinking of a caisson, and fig. 4 a group of workmen riveting a caisson.

On July 11 the track was completed to Petropavlovsk (329 miles) and the first locomotive was met by the local authorities with great ceremony.

Near Petropavlovsk the Tshim River is crossed, for which an iron bridge 700 ft. long (two spans 350 ft.) is designed. The girders will be semiparabolic, of the same type as for the Tobol and Irtish bridges.

The track-laying advances rapidly, the conditions existing in a level country being favorable. All the material (rails, accessories and ties) is carried daily by two trains of thirty cars* each. The ties are carried forward by means of horses, and only the rails and accessories are carried by means of small bogies, which are forwarded with the track-laying. The track-laying advances at the rate of from 3 to 4 miles every day. Thus far it has started from Chelabinsk only, but in June it was begun also from Omsk, where rails, accessories and ties have been brought by river navigation. The track-laying between Chelabinsk and Omsk (484 miles) is advancing now from two starting points in both directions, and the last rail on this section it was expected would be laid on August 17, 1894, in presence of the Minister of Ways and Communications, Mr. Krivoshein.

The track-laying will be extended from Omsk eastward 100 miles this year. It will be completed to the Obi River in the summer of 1895.

The Irtish bridge (two of 100 ft. span) will be begun this winter; and the foundations at the Obi River were laid between July 29 and August 3, 1894, in presence of the chief engineers of both the neighboring lines, the Western Siberian and Central Siberian.

The Central Siberian Railroad, from the Obi River to Irkoutsk, according to the last programme, will be completed in 1898. The work was begun in 1893 on the first section, and work on the Obi River, Krasnoiarsk (480 miles), has been started this year on the whole line. The earthwork has advanced rapidly, and the track-laying has also been started from the Obi River; in 1893 16 miles were laid, and in 1894 it is proposed to lay about 100 miles. The branch to Tomsk (60 miles long) was designed in 1893; but the location of the second section (Krasnoiarsk to Irkoutsk) was begun in 1894.

The terminus of this line (Irkoutsk) is the best and largest city in Siberia; it has 45,000 inhabitants. The railroad station is located on the left side of the Angara River, opposite Irkoutsk City, and is situated on the right side of that river near the estuary of Irkout River.

From Irkoutsk to Baikal Lake (Listvenichnaia Harbor) a branch line will be completed in 1898. In this way, and with the steam ferry on the Baikal Sea in 1898, the European railway system will be uninterruptedly connected with the heart of Siberia at Irkoutsk, and, by the navigation of the Amour River, it will be connected with the Pacific terminus at Vladivostok.

The section of the Great Siberian Railroad (the Baikal loop line) from Irkoutsk to Missovskaia Harbor (194 miles) will now be definitely located, and the construction of it will be completed in 1901.

The Trans-Baikal Line, from Baikal Lake to Sretensk, on Shilka River (679 miles) is now definitely located, and the construction of it, starting this year, will be completed in 1898.

The Amour Line (from Sretensk, on Shilka River, to Khabarovka, near the estuary of Oussouri in Amour, about 1,300 miles) has not yet been surveyed; but Mr. B. Savrimovich, C.E., has recently been appointed Chief Engineer of Surveys. The surveys will present great difficulties, the country being entirely uninhabited. The construction of this line, crossing an entirely unknown country, will not be completed until 1901.

The last section of the Great Siberian Railroad (the Western

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* Presided over by the present Czar, Nicholas II.

* The Russian goods cars carry from 10 to 12 tons.

or Oussouri section) consists of two lines—North Oussouri Line and South Oussouri Line.

The North Oussouri Line (from Khabarovka, the administrative center of the Amour territory, to the Grafskala, 232 miles) is now located. Its construction will be begun in 1895, and will be completed in 1898.

The South Oussouri Line (from Grafshala to Vladivostok, 254 miles) was the first of the whole system of Siberian railroads which was commenced. Work was started on it in 1891. The construction of this line has been very difficult, and many hindrances have been encountered from the local conditions, want of workmen (a great part of whom were exiles and criminals), and the entire separation from the metropolis. The earthwork was generally very heavy. Nevertheless, 124 miles of track are already laid, is open to traffic, and in the spring of 1895 the whole line will be finished.

THE UNITED STATES TRIPLE-SCREW CRUISERS "COLUMBIA" AND "MINNEAPOLIS."*

By George W. Melville, Engineer-in-Chief, U. S. Navy.

These two vessels have been more prominently before the public than any other of our new vessels from the first descriptions of their design, and the great success which has attended their official trials has doubtless led the Executive Committee to suggest them as a subject for a paper.

Although I had the honor of recommending the use of triple screws on these vessels, it is hardly necessary to tell this Society that the use of triple screws was not a novelty, and that any credit in the matter arises simply from their use for machinery of much greater power than had previously been attempted, and for persisting in the design against the advice of some of my best friends in the profession, who believed it too much of an experiment.

When I was asked to design machinery of about 21,000 I.H.P. for the *Columbia* there were a number of questions which came up for consideration. One was that of securing economy at moderate speeds when full speed was so high, and another was that of the shafting. When the design was under consideration no steel shaft had yet been made in this country for the transmission of as great a power as 10,000 horses, and while I had every confidence in my friend John Fritz and the Bethlehem Iron Company, I felt that it would be safer to adopt a design which would give us smaller shafting. The alternative to triple screws was twin screws, either with one very large engine or two smaller ones on each shaft. The former meant large parts of the machinery all through, and the latter great multiplication of parts.

The French experiments on the *Carpe*, and the trials of the *Tripoli* had demonstrated that there was no doubt of the practical success of triple screws, and the preliminary design of the *Dupuy de Lôme* with triple screws showed that the French were satisfied with the *Carpe* experiments. I believed, also, that we would find it more economical to run one engine of a size for 7,000 I.H.P. at about 2,000 than to run two 10,500 I.H.P. engines, or even two 5,000 I.H.P. engines, even if it did involve dragging the idle screws, allowed to revolve freely. I had hoped to be able to give some figures on this point, as an attempt was made, during the return trip of the *Minneapolis* from her official trial, to secure a comparison of the horse-power and coal consumption when making the same speed with one, two, and all three screws, but fog and other circumstances interfered, and the speed had to be determined by the patent log, so that the results obtained cannot be considered as at all conclusive. The *Columbia* is now on active service, and by our next meeting I may be able to give reliable data as the averages of considerable periods.

It is, however, obvious that, even if the drag of the two idle screws should require enough additional power to make the actual cost of propelling the vessel at a given speed in pounds of coal per hour nearly as great as the similar cost of driving her by the after engines of twin screws with a pair on each shaft, there is a gain in economy of maintenance and in convenience. We have been compelled in the *New York* and the *Brooklyn* to make special provision for the wearing down of the shaft bearings of the after engine, and in the *Blake* of the English Navy, where the attempt has been made to avoid this difficulty by using the forward and after engines on each shaft alternately, it is necessary to disconnect all the connecting rods and eccentric straps, which is certainly inconvenient, and involves considerable delay when it is desired to use both engines for higher powers.

When the *Columbia* and the *Minneapolis* were designed, we hoped to secure a speed of about 22 knots for the maximum I.H.P. of 21,000, and while some enthusiasts predicted higher speeds, those of us who were more conservative felt that 22 knots was about all we could reasonably expect. The news that the *Columbia* had made 22.8 knots was, therefore, both gratifying and astonishing when the official report showed that it had been made for only about 18,500 I.H.P. This seemed so remarkable that I urged the Trial Board to go over the computation of the H.P. again with great care, which was done without the detection of any error. When the complete data were received I had one of my most capable assistants, an expert in these matters, revise all the work, but he could detect no error anywhere. After this performance it was, of course, reasonable to expect still better results from the *Minneapolis* if she should develop the full 21,000 I.H.P., and, as you know, such was the case, an average speed of 23.07 knots being secured, making her the fastest large vessel in the world, and, for the length of her trial, the fastest vessel, large or small.

In an appendix are given the dimensions of hull and machinery of the *Columbia* and the *Minneapolis*, together with the data of their performances on trial. There is also given a brief historical sketch of the use of multiple screws prepared by one of the younger officers of the Engineer Corps, Passed Assistant Engineer Thomas F. Carter, U. S. Navy, and first published in the *Journal* of the American Society of Naval Engineers, and this will undoubtedly prove interesting.

As already remarked, the economy of propulsion in the case of the *Columbia* was so marked as to suggest comparison with other fast vessels, and it was at once apparent that the gain in economy was considerable. A natural comparison is with the *New York* and the *Olympia*, and I have brought the *New York* and the *Minneapolis* to the displacement of the *Olympia* by Froude's law. As the vessels are all of considerable size, the error due to not calculating the frictional resistance separately is negligible. Inasmuch as the speeds thus found are not all the same, and as it is desirable to make the comparison at the same speed, I have calculated the exponential relation of speed and power from a curve for a 5,000-ton vessel constructed by Froude's Law from the progressive trials of another ship where speed and power were determined with unusual care. Calling the ratio of speeds a, and the ratio of powers b, we have $a^x = b$, where x is the exponential relation desired. Then $x \log a = \log b$, and $x = \frac{\log b}{\log a}$.

Taking speeds and powers as follows:

	Speeds.	Powers.
(1)	15.00	3,175
(2)	17.60	6,230
(3)	19.90	10.150

we get the following table:

Ratios.	Speeds a.	Powers b.	Log a.	Log b.	x.
1 : 2	1.17	1.96	.0682	.2923	4.28
1 : 3	1.325	3.20	.1222	.5051	4.12
2 : 3	1.13	1.63	.0531	.2123	4.00

We shall not be far wrong then in assuming that the powers vary as the fourth power of the speeds.

Applying Froude's Law, and bringing the speeds of *Olympia* and *New York* to that of the *Minneapolis*, as already stated, we get the following table:

Name of vessel	Minneapolis.	New York.	Olympia.
Trial displacement	7,387.5	8,480	5,586
Length on L. W. L.	411.6	380.0	340.0
Beam	58.2	64.25	53.05
Mean draught	22.5	23.9	20.78
Block coefficient	0.478	0.509	0.517
Trial speed	23.07	21.00	21.686
" I H.P. (main engine)	20,366.2	16,947.3	16,849.83
Reduced displacement	5,586	5,586	5,586
Reduced speed	22.00	19.60	21.686
" I.H.P.	14,750	10,400	16,849.8
I.H.P. for 22.00 knots at reduced displacement	14,750	16,500	17,847
Percentage of gain in economy of propulsion of triple screws over twin screws	....	11.9	21.00

* Paper read before the Society of Naval Architects and Marine Engineers. Copyrighted.

When such a gain as this is shown, the most natural thing is to search for the cause, and here we are met with obstacles at the very start. Probably, after some consideration, the first suggestion would be that the center screw is very favorably placed for securing whatever benefit there may be from working in the forward current of the frictional wake. This would doubtless be accepted but for the fact that most of the authorities on screw propulsion have stated that while the screw itself would be helped, any gain in this direction would be offset by the increased resistance of the vessel due to the action of the screw interfering with the stream line action. It should be said, however, that most of the authorities simply state this as a proposition, without attempting any demonstration or quoting experimental data to confirm the statement. I am inclined to believe that this statement has been based on Froude's classic experiments on the *Greyhound*, and it is hardly necessary to remind this Society that, while the experiments themselves were admirable in every way, the *Greyhound* had a very poor model compared with modern steamers, and her machinery also was much different from that we now use. As a result, the data of the *Greyhound* experiments are of very little use as a guide for modern hulls and machinery. For example, Froude gave as a result of his experiments that the effective H.P., or power actually applied to overcome the resistance of the hull was only from 37 to 40 per cent. of the I.H.P. of the engines. About 10 years or so ago the late Mr. William Denny quoted a case where a comparison of the I.H.P. with the effective H.P. as determined by model experiments made by the younger Froude had shown the ratio to have risen to 60 per cent., and some calculations that I have had made for some of our new ships has shown the ratio to be, in some cases, nearly 75 per cent. I feel, therefore, that we should not let our admiration for Mr. Froude's great reputation lead to the unqualified acceptance of statements based on his experiments on the *Greyhound*.

Another objection, also, comes from the fact that there has gradually grown up a belief that propulsion by twin screws is more economical than by a single screw. This belief, I think, is based to a great extent on the admirable paper reau by my friend, Dr. White, the Director of Naval Constructiop of the British Navy ,before the Institution of Naval Architects in April, 1878, where he showed that a comparison of some single and twin-screw ships of the British Navy indicated a decided economy in propulsion by twin screws. I give below a table from his article* simply to call attention to the fact that a part of the reason for the increased economy of twin screws may have been due to their smaller diameter and greater helicoidal area. It will be observed at once that the slip of the single screws is very much greater than that of the twin screws, and by calculating the indicated thrust per square foot of helicoidal area it will be found that it is nearly twice as great for the single screws as for the twins. We are accustomed to allowing more indicated thrust for small, quick-running propellers than for large, slow-moving ones; but here the conditions are reversed. It is to be noted also that the speed of tips of the single screws is about 17 per cent. greater than that of the twins, which would make the resistance per square foot nearly 40 per cent. greater.

Whatever may have been the cause of the marked superiority of the twin-screw ships over those with single screws, it is to be noted that there are numerous instances of single-screw ships in which the I.H.P. per square foot of wetted surface is less than for the war vessels quoted by Dr. White. For example, the steamship *Charles V.*, built by Messrs. A. & J. Inglis, has an immersed surface of about 15,180 sq. ft. She is 323 ft. on L.W.L. by 33 ft. 9 in. beam, and on trial had a mean draft of 14 ft. 10 in., giving a displacement of 2,478 tons. At 14 knots the I.H.P. was 1,575, or 0.104 I.H.P. per square foot of wetted surface. Another vessel, the *Rotomahana*, has 13,650 sq. ft. of wetted surface, and is 285 ft. × 35 ft. 2 in. × 15 ft. 7¾ in., displacing 2,548 tons. At 14 knots the I.H.P. is 1,925, or 0.141 I.H.P. per square foot of wetted surface.

It may be objected that these vessels are much smaller than the war vessels, and also that the ratio of wetted surface to displacement is higher, thus giving a larger divisor. Data are available, however, of the performances of some larger merchant ships. Thus the *Umbria* and *Etruria* have 43,980 sq. ft. of wetted surface, 13,300 tons displacement, and are 500 ft. × 57 ft. 6 in. × 26 ft. 6 in. At 14 knots the I.H.P. per square foot of wetted surface is 0.121. In the case of the *Oregon*, the ratio was 0.118; in the *Servia*, 0.119, and in the *Gallia*, 0.127.

These cases all go to show that, so far as a comparison based on I.H.P. per square foot of wetted surface is concerned, the single-screw vessels made an even better showing than those with twin screws whose performances have been quoted. The *New York* and the *Olympia*, however, make a better showing than the older twin-screw vessels, giving, at 14 knots, the *New York* 0.115 I.H.P. and the *Olympia* 0.146 I.H.P. per square foot of wetted surface, or about the same as the single-screw merchantmen.

The facts thus stated would seem to leave it at least an open question whether the increased economy of the triple screws is not due to the center screw working in the wake, but there are others which make it seem the probable solution. When the *Columbia* was designed there was a general belief that the race from the side screws would cause the center screw to work in water having a sternward motion, and it was the intention to give it about 10 per cent. more pitch than the side screws. However, before the *Columbia* was tried, it was learned that the trials of the *Kaiserin Augusta*, the German triple-screw vessel, had shown that, if given such an increase of pitch, the center screw could not work up to the designed number of revolutions. When the *Columbia* was tried, all the screws were given the same pitch (21 ft. 6 in.), but the center screw ran some five revolutions per minute slower than the side screws, and the mean effective pressure of its engine reduced to the low-pressure cylinder was nearly 8 lbs. more than that of one of the side screws. In the case of the *Minneapolis*, the pitch of the center screw was set at 6 in. less than that of the side screws (21 ft. 6 in. and 22 ft.), and ran about one revolution faster than they with an aggregate mean effective pressure greater by 8 lbs. and nearly 700 more I.H.P. Now, clearly, this can only be explained by assuming that the forward wake exerts a very strong pressure, and, as we have the undoubted facts of the high-speed and moderate H.P., the action of the screw cannot have interfered with the stream in action enough to increase the resistance of the ship.

Thus, it seems to me, that the most reasonable explanation of the increased economy of propulsion is that, in an unusual degree, the center screw, which occupies the same position as the propeller in single-screw vessels, profits by the forward motion of the frictional wake, and this without interfering with the stream line motion sufficiently to increase the vessel's resistance.

In discussing this question of the greater efficiency of triple screws with some friends, it was suggested that possibly it was not entirely fair to compare the performances by Froude's Law, because the *Minneapolis* is longer than the *New York* and the *Olympia*, and, therefore, better adapted to high speeds, as the wave-making resistance would be less proportionally than for the shorter ships. While I did not believe that any difference due to this cause could account for the material difference which exists, I thought the suggestion worthy of examination, and so have had one of my assistants calculate the power required to tow each ship at the speed she actually made on trial, dividing it into skin-friction and wave-making resistance, using the formulæ and constants given in the recent work of my friend, Naval Constructor Taylor, entitled "Resistance of Ships and Screw Propulsion."

These calculations take cognizance of the slight variation in the coefficient of skin friction, due to the difference in length, as well as the influence upon the wave-making resistance of the relation between length and displacement. The power thus found is the useful work done in propulsion, and its ratio to the H.P. of the engines may be called the efficiency of propulsion.

It may still be objected that the comparison should be between the useful work and the power delivered to the propeller shaft, but, in addition to the trouble of making the calculation, it is to be considered that we are comparing the systems, including the engines, and that if, on the one hand, it be thought that the *New York* is at a disadvantage on account of having four engines, the *Olympia*, on the same line of reasoning, would be at an advantage as having only two.

The formulæ used are:

For skin-friction resistance, $R_f = f.\ S.\ V^{1.83}$, where

f = coefficient of skin friction from Taylor's tables.
S = wetted surface.
V = speed in knots per hour.

For wave-making resistance, $R_w = b_o \dfrac{D^{\frac{2}{3}}}{L} V^4$, where

b_o = coefficient taken from Taylor's data.
D = displacement in tons.
L = length on load water line in feet.
V = speed in knots.

* Table omitted from this report.

LOCOMOTIVE RETURNS FOR THE MONTH OF AUGUST, 1894.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage. Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Av. Train. Passenger Cars.	Freight Cars.	Coal Burned per Mile. Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Cost per Locomotive Mile. Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Cost per Car Mile. Passenger.	Freight.	Cost of Coal per Ton.
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Atchison, Topeka & Santa Fé	864	757				1,[illegible],214	2,469						84.35			4.36	6.33	0.44		5.74	1.57	21.44			1.90
Canadian Pacific	607		512,180	805,796	448,873	1,[illegible],858							64.36			2.68	9.44	0.19		5.65	1.14	19.63		1.76	2.96
Chic., Burlington & Quincy		541				1,[illegible],777	2,706	5.17	20.36				88.41			3.49	5.47	0.30	0.12	7.03		16.30			1.36
Chic., Milwaukee & St. Paul		554				[illegible],192	2,686						68.21			3.29	6.59	0.26		6.86		17.01			2.10
Chic., Rock Island & Pacific	563		500,441	858,169	304,458	1,[illegible],068	2,946	5.50	19.30				90.14	9.67	4.12	3.01	5.88	0.38		6.02	0.37	15.45			1.68
Chicago & Northwestern	1010		896,019	1,361,894	699,077	2,896,990	2,869						75.30			3.06	6.71	0.97		7.14		19.15			2.31
Cincinnati Southern																									
Cumberland & Penn.*		23	6,491	40,609		47,080	2,045						88.18			5.67	4.49	0.34			1.49	11.99			
Delaware, Lackawanna & W. Main L.	212	198	70,580	186,985	380,382	644,327	3,355						79.79			3.94	6.04	0.42		5.38		15.33			1.50
Morris & Essex Division	162		188,454	145,600	75,707	418,741	2,594						88.41			4.51	9.17	0.65		6.91		20.65			3.11
Flint & Père Marquette		84	96,799	86,154	53,690	212,673	2,542			51.77	78.75	50.46	60.96			2.76	5.76	1.14		5.01	0.98	14.60			1.60
Hannibal & St. Joseph		69	67,639	131,943	36,555	236,136	3,578	5.11	17.98				75.69	13.38	5.74	2.27	5.46	0.11	0.22	6.07	0.04	14.76			1.44
Kansas City, Ft. S. & Memphis	140		95,753	168,814	74,491	339,058	2,995						60.83			3.44	4.39	0.35	0.47	7.34		15.99			1.36
Kan. City, Mem. & Birm.	43	37	24,120	59,765	14,946	101,833	2,752						65.29			3.58	2.51	0.39	0.30	6.76		13.74			0.97
Kan. City, St. Jo. & Council Bluffs		17	49,796	41,005	40,390	131,191	3,649	5.15	23.61				60.16	19.14	4.41	3.04	5.59	0.18	0.40	6.69	0.08	15.98			1.70
Lake Shore & Mich. Southern																									
Louisville & Nashville																									
Manhattan Elevated		280	710,711		64,068	774,779	2,758						34.09			2.30	6.90	0.30	0.40	9.50		19.20			4.06
Mexican Central	148	133				458,894	3,447						66.86			4.81	12.94	0.43	0.13	4.86		23.17			3.88
Minn., St. Paul & Sault Ste. Marie																									
Missouri Pacific		351				945,948	3,316	4.39	17.11				73.92			5.49	5.24	0.30	1.68	6.35	1.38	20.50	4.97	1.39	1.41
Mobile & Ohio	106	80	63,941	137,616	54,134	256,691							61.78			3.79	3.95	0.28	0.64	5.58	1.08	14.30			1.38
N. O. and Northeastern																									
N. Y., Lake Erie & Western	629		463,905	759,804	243,749	1,467,458	2,628	4.80	16.60	67.10	127.90		94.10	18.90	5.30	4.13	7.26	0.34	1.84	7.36	1.29	23.15			1.39
N. Y., N. H. & H., Old Colony Div.			445,688	157,498	152,011	755,197	3,558	4.10	16.90				61.69	14.80	4.70	2.98	8.58	0.54		6.90	0.55	19.44			
N. Y., Pennsylvania & Ohio	976		187,291	304,918	158,567	665,771	3,209	6.30	19.30	75.40	118.70		91.05	12.30	5.90	2.66	5.32	0.39	1.67	7.03	0.96	17.65			1.07
Norfolk & Western, Gen. East. Div.†		40	107,819	374,836	60,149	542,804	2,762	5.94	16.27	68.00	130.00		100.31	13.37	7.69	6.14	3.78	0.34				13.16			
General Western Division†			100,138	341,309	58,958	495,297	2,984	5.60	20.71	44.44	113.13		68.75	7.92	5.40	6.69	3.36	0.37				10.16			
Ohio and Mississippi																									
Philadelphia & Reading			471,989	880,029	333,834	1,685,851							67.51			4.60	4.50	0.34		5.59	0.49	15.88			
Southern Pacific, Pacific System	728	648	651,198	1,102,996	279,601	2,033,795	3,138	5.85	18.87				71.29			4.60	17.96	0.19	1.95	7.58	1.04	33.32			4.75
Union Pacific		440	457,671	791,607	207,198	1,446,461	3,297	6.16	19.65				44.78			6.49	8.63	0.40		7.67	1.08	24.35	3.50	1.65	1.85
Wabash	416	354	486,537	732,697	235,711	1,406,945	3,974	4.88	16.37				60.22			3.35	4.71	0.31		5.67	0.77	14.81	2.74	1.01	1.11
Wisconsin Central	149	110	148,317	175,730	90,014	414,061	3,764						69.11			2.92	6.77	0.15		6.67		15.81			1.94

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars. Empty cars which are reckoned as one loaded car are not given upon all of the official reports, from which the above table is compiled. The Union and Southern Pacific, and New York, New Haven & Hartford rate two empties as one loaded; the Kansas City, St. Joseph & Council Bluffs, and Hannibal & St. Joseph Railroads rate three empties as two loaded; and the Missouri Pacific and the Wabash Railroads rate five empties as three loaded, so the average may be taken as practically two empties to one loaded.

* Switching engines allowed 5 miles per hour; wood, construction and gravel trains, 10 miles per hour.

† Wages of engineers and firemen not included in cost.

We then get the following table :

	Speed knots.	Skin friction resistance. Lbs.	Wave-making resistance. Lbs.	Total resistance. Lbs.	I.H.P. for useful work.	I.H.P. on trial.	Percentage of efficiency.
Minneapolis...	23.07	82,030	104,420	186,450	13,790	20,366	67.72
New York.....	21.00	73.380	85,360	159,240	10,268	16,947	60.59
Olympia.......	21.69	61,375	82,150	143,525	9,560	16,850	56.73

The increased efficiency of the triple screws over twins is thus, in the case of the *New York*, 11.8 per cent., and in the case of the *Olympia*, 19.38 per cent.

In comparisons such as we have been making, a very important matter must not be overlooked—the standardization of the indicators and the correction of the mean pressures for the errors found. Since the trial of the *Yorktown*, in February, 1889, the first case in which the indicator errors were considered, nearly a thousand tests of indicators have been made and reported to the bureau of which I am chief, and we have found that indicators submitted as first-class have, in many cases, shown errors so great that allowance for them would reduce the mean pressure as much as 10 per cent. Until recently it was assumed that the indicators were correct, so that it may have happened that differences in H.P., on which serious arguments were based, were not real, but due to one set of indicator springs having a very large error.

In the comparison of the performances of the *New York* and the triple-screw ships, I feel assured that we do not run this risk, as the indicators in each case were tested by the same officer, who is probably the best expert at such work in the country, the errors were in every case moderate, and the mean pressures were in all cases corrected. The indicators of the *Olympia* were also standardized, but by another officer, and by a slightly different method. I believe her H.P. is substantially accurate, but it is not comparable with the others with the same strictness as they are with each other.

As has already been stated, it was not anticipated, when triple screws were adopted, that their use would give any increase of economy of propulsion, their adoption being due mainly to constructive reasons, and incidentally to secure economy at cruising speeds. It appears now, however, that this method does give an increase of economy at maximum powers. It would seem, therefore, that, for very high-speed ships, this arrangement would commend itself, and, if it were not dangerous to prophesy, I should be prepared to anticipate the adoption of triple screws for all the new "flyers" that enter for the transatlantic race. In this connection the closing remarks of Dr. White, in the paper already referred to, are highly interesting, and it would seem that, by substituting triple for twin screws, and *Minneapolis* for *Iris* his remarks would apply now. They are as follows :

"Looking to the future of steam navigation, one thing seems certain—greater speeds will be attained than are now reached. It does not seem probable that any considerable increase in fineness of form, or in the ratio of length to breadth, will be adopted in future ships for the purpose of diminishing their resistance. Any increase in the load-draughts is also clearly inadmissible. The greater engine powers which will probably be used in the swifter ships will consequently have to be applied on a limited draft of water ; and hence it may be anticipated that at no very distant date the designs of swift mail steamers will be subject to conditions resembling those sketched above for the *Iris*. The extreme draft will not permit a use of the single screw with a disk area bearing anything like the ordinary ratio to the I.H.P. ; and it will become necessary either to depart from established precedents in the ratio of pitch to diameter of single screws, to adopt twin screws, or to accept greater speeds of pistons and propellers than are now common in large marine engines. At the present moment there is no great urgency in deciding between these rival methods, and I have no wish to attempt a prediction as to the practice of the future. The matter is, however, one well deserving the careful consideration of marine engineers and naval architects."

A few words more and I shall finish. It would be a natural supposition that, having built the two fastest cruisers in the world for our Navy, every naval officer would rejoice at their possession and be proud of them. I regret to learn, however, that we are in a mild way repeating the experience of the *Wampanoag*, which, as some of you may remember, was declared a failure by a board of naval officers, although she was far and away the fastest vessel in the world, being several knots faster than anything else afloat, and, as some believe, an important factor in the settlement of the Alabama claims at Geneva. Now the cry is raised that, although we have the fastest ships, they cannot carry coal enough to go across the ocean at full speed. In fact, some say that we don't want such fast ships ; and others, echoing the jealous wails of a few of our transatlantic friends, have actually talked about the ships being failures.

It seems very hard to satisfy our critics. Before we began the building of our new Navy it was constantly hurled in our teeth that we were behind the times ; that we couldn't build as good ships as they did abroad, and so on to the end of the chapter. Now we have beaten our foreign friends, and we are told that fast ships are useless. It seems to me that the idea so cleverly put by my friend, Nixon, of Cramp's, in regard to battle ships is equally true of fast cruisers. Explaining why we should not rely on monitors alone, he said : "You can't get as much fight out of two million dollars as out of five." So it is with these fast cruisers. We don't want our Navy to consist of them alone, and, as I said here last year, I believe, for mere peace cruisers, we have overspeeded many of our ships ; but in time of war I believe there is a great field for just such ships as our triple-screw cruisers—the fastest vessels now afloat.

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

THE object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publications will in time indicate some of the causes of accidents of this kind, and to help lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with the information which will help make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a great favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in October, has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS IN OCTOBER.

Toledo, O., October 1.—Train wreckers succeeded in wrecking a passenger train on the Wabash Railroad at Maumee, 12 miles south of here to-day. F. N. Smith, engineer, was killed, and A. H. Day, fireman, fatally hurt.

Buffalo, N. Y., October 1.—Charles Avery, an engineer on the Lehigh Valley Railroad, had his foot crushed between a draw-head of an engine and a flat car to-day.

Benson, Ariz., October 1.—E. G. Roesler, an engineer, was seriously scalded by the bursting of a flue on an engine of the Mexico & Arizona Railroad, and died of his injuries.

St. Joseph, Mo., October 1.—A passenger train on the Atchison, Topeka & Santa Fé Railroad collided with a freight train on the Kansas City, St. Joseph & Council Bluffs Railroad south of here, as a result of disobedience of train orders by the freight. C. E. Page, engineer on the passenger train, had his leg broken and was internally injured.

San Francisco, Cal., October 2.—Martin Ford, an engineer on the Southern Pacific Railway, was caught between cars, and had his pelvis crushed ; he is in a precarious condition.

Baraboo, Wis., October 2.—A cattle train on the Chicago & Northwestern Railway ran into a freight train at Lavalle this morning. Engineer Sullivan received severe injuries.

Leavenworth, Kan., October 2.—A special passenger train on the Missouri Pacific Railroad ran into an open switch at South Leavenworth to-day. Engineer Alix McCambridge jumped, and was severely cut about the face. Fireman Lee Blanchard also jumped, and sustained injuries of the arm.

Laredo, Tex., October 2.—A wreck occurred on the Mexican National Railway near Monterey to-day. A double-header freight train struck a cow, ditching both engines. Engineer Dan Drennan was killed outright, and Engineer Joe Sharp was scalded, from the effects of which he died in the evening.

Wakefield, Mass., October 4.—An extra passenger train on the Boston & Maine Railroad ran into a freight train at this point to-day at noon. The engineer and fireman of the extra were badly injured.

Smithfield, Mo., October 4.—An engine and 12 cars on the Union Pacific Railroad jumped the track at this point. Engineer Mike Ketchum and Fireman Tom Warren were instantly killed.

Bristol, Tenn., October 7.—A train wrecker put a bolt on a rail on the Southern Railway near here to-day, causing an express train to jump the track. Samuel Smith, engineer, had his leg broken, was scalded, and was buried under the wrecked train, and will probably die from his injuries. Will Holmes, fireman, had his head cut and was badly scalded.

Tomahawk, Wis., October 8.—Train wreckers sawed the timber supporting the Sou Line Railway bridge at Tomahawk, and wrecked the west-bound passenger train. The engine plunged into the river, and the body of the fireman is buried beneath the engine. The engineer had both his legs broken.

Rochester, N. Y., October 8.—In a collision between two freight trains on the New York Central & Hudson River Railway at Walworth to-day, Fireman George Soulier sustained fractures of three ribs and was otherwise injured.

Memphis, Tenn., October 8.—A fast mail train on the Louisville & Nashville Railroad was wrecked at a siding 67 miles from here to-day. Engineer Joseph Lewis and Fireman James Burnes were seriously injured.

Clinton, Ia., October 8.—Engineer John Haley jumped from his engine at La Force this morning, thinking that a collision with a train on a siding was inevitable; he struck a switch and was torn almost in two.

Seymour, Ia., October 8.—A freight train on the Chicago, Rock Island & Pacific Railroad jumped the track at Sleepy Hollow this morning. Engineer Gerald Nolan and Fireman Marshall Lowe were instantly killed.

Pittsburgh, Pa., October 9.—Fireman Frank George was instantly killed on the West Penn Railroad by being struck by a passing train.

Flagstaff, Ariz., October 9.—A passenger train on the Atchison, Topeka & Santa Fé Railroad ran into a steer 50 miles east of here to-day. The engineer and fireman were slightly hurt.

Asheville, N. C., October 9.—A freight train on the Asheville & Spartanburg Railroad ran away down a heavy grade on the Salada Mountain this morning; the train was wrecked at the bottom, and Fireman York was buried under the wreckage and killed.

Shreveport, La., October 10.—A freight train on the Texas & Pacific Railway ran into some loaded cars near here to-day. The engineer had his leg broken, and was scalded about the head and face; Fireman Tom Hurndon had one hip dislocated and both legs broken.

Brooklyn, N. Y., October 10.—Frank E. Grady, a fireman on the Brooklyn Elevated Railroad, while at work slushing the front end of his engine, was thrown from his position and jammed between the wheels of the engine and a girder by the side of the track. His left leg was entirely severed and his body was frightfully crushed.

The Dalles, Ore., October 12.—A passenger train on the Oregon Railway & Navigation Company's Line was wrecked near here to-day. The fireman and engineer were seriously injured.

Montclair, N. J., October 12.—A boiler exploded on the Delaware, Lackawanna & Western Railroad at this point to-day. The fireman was killed and the engineer fatally injured.

Springfield, Ill., October 12.—A train wrecker drove a coupling pin into a frog in a switch of the Wabash Railroad at Rivington, wrecking the passenger train. Engineer Stewart and William Jones are badly injured.

Chicago, Ill., October 12.—John Haley, an engineer on the Chicago & Northwestern Railroad, jumped from his engine to-day, when it ran over a man, and was killed.

Newbern, N. C., October 16.—A freight train on the Chesapeake, Ohio & Southwestern Railway was wrecked 2 miles west of here this morning. Engineer McCaine and Fireman Kilcoyne were dangerously injured. The wreck was caused by train wreckers placing ties across the trestle.

Richmond, Va., October 18.—A collision occurred in the yards of the Richmond, Fredericksburg & Potomac Railroad near Acker Station to-day. Engineer John S. C. Eastman was seriously injured, as was also Engineer Bryant.

Fall River, Mass., October 19.—A collision occurred on the New York, New Haven & Hartford Railroad this morning at Drownville. Two firemen were hurt, one having his ankle broken.

Philadelphia, Pa., October 20.—A passenger train on the Philadelphia, Wilmington & Baltimore Railroad ran into a freight train at Glen Mills to-day. Engineer Rambo jumped from his engine, and was slightly hurt.

Wheeling, W. Va., October 20.—A fast express train jumped the track at Willard Tunnel early this morning. Engineer Cummins and Fireman Owings were seriously hurt.

Cumberland, Md., October 20.—Charles F. Fredericks, an engineer on the West Virginia Central Railroad, was killed here this morning by being caught between two trains.

New Orleans, La., October 20.—A freight train on the Illinois Central Railroad jumped the track near Calhoun Station, Miss., this morning; Engineer Cotton had his wrist dislocated.

Kansas City, Mo., October 21.—A freight train on the Union Pacific Railway ran into an open switch to-night and plunged down a 15-ft. embankment. The engine men jumped and were slightly injured.

Delaware, O., October 22.—A parallel rod on a pushing engine on the Columbus, Hocking Valley & Toledo Railroad was broken here to-day. The engineer, on reversing the engine, broke the other bar; he is badly injured and suffers from a dislocated knee-cap.

San Antonio, Tex., October 22.—A collision occurred between a passenger and stock train on the Southern Pacific Railroad near Walker to-night. Con Connors, the engineer of the freight, had both legs broken, and will probably die; Carl Hunsacker, fireman of the freight, was less badly injured about the legs.

New York, N. Y., October 22.—George Chase, an engineer on the New York, New Haven & Hartford Railroad, was fatally scalded this afternoon by the bursting of a steam pipe at New Rochelle; the fireman was also scalded, but not so severely.

Camden, O., October 22.—Robert Hodgin, Jr., a fireman on the Cleveland, Cincinnati, Chicago & St. Louis Railroad, was seriously injured by being struck by a water-tank pipe at Barnet's Station, 2 miles north of here to-day.

Boston, Mass., October 24.—A misplaced switch in the yard of the New York, New Haven & Hartford Railroad was the cause of a collision between two trains to-day. Engineer Nicols was hurt about the arms, and Engineer Winchenbach was somewhat injured.

Olathe, Kan., October 24.—A freight train on the Kansas City, Fort Scott & Memphis Railroad ran into an empty box car that had blown on to the main line from a side track. Fireman Lincoln Stewart was killed by being buried under the ruins. Engineer Smith jumped, and was severely injured by dislocating the left shoulder and receiving internal injuries.

Atlanta, Ga., October 26.—An engine and 30 cars on the Macon & Northern Railroad went through a burning trestle this morning. Engineer Gay was instantly killed by being scalded to death.

Bristol, Pa., October 28.—A fast freight train on the Pennsylvania Railroad crashed into the rear end of a work train at Croyden Station this morning. The engineer of the freight, Ed. Stow, jumped from his engine, and sustained a scalp wound and severe contusion of the body; Henry Kenney, fireman of the construction engine, had his shoulder fractured.

Boston, Mass., October 28.—An engine on the Boston & Maine Railroad suddenly left the rails and capsized on an embankment near Orient Heights this morning. Engineer Peter Hanson was internally injured.

Lima, O., October 29.—A fast freight on the Pittsburgh, Fort Wayne & Chicago Railroad was run into at the rear east of Ottowa Bridge to-day. Engineer John Koehler and Fireman E. D. Rhoades were severely injured, but not seriously.

Scranton, Pa., October 30.—An express train on the Delaware, Lackawanna & Western Railway ran into an open switch near here to-day, and collided with the rear end of a coal train. Engineer Lynott was instantly killed, and Fireman Elmer Scull received fatal injuries. On the passenger train, Valentine Butler, the engineer, escaped with a few bruises; Fireman Hosey was caught in the wreck of the engines and scalded to death.

Our report for October, it will be seen, includes 44 accidents, in which 13 engineers and 11 firemen were killed, and 28 engineers and 20 firemen were injured. The causes of the accidents may be classified as follows:

Boiler explosion	1
Broken side rod	1
Burned trestle	1
Cars blown on track	2
Cattle on track	2
Caught between cars	2
Caught between engine and cars	1
Collisions	10
Derailments	6
Flue bursting	2
Jumping from engine	2
Misplaced switch	4
Runaway train	1
Run over	1
Struck by obstruction	1
Thrown from engine	1
Train wreckers	5
Unknown	1
Total	44

WATER-TUBE BOILERS AND THEIR APPLICATION TO WAR VESSELS.*

By J. Nastoupil.

Water-tube boilers are boilers wherein the water to be evaporated is contained in tubes whose walls are in direct contact with the gases of combustion, and therefore form the heating surfaces of the boiler. As the water contained in the tubes is heated it rises into the space above, causing a circulation in the boiler. While the warm and specifically lighter water rises into the water space above an equal amount of cooler and specifically heavier water descends.

Such a circulation is shown in fig. 1, where the heated water rises at *B*, while the cooler water flows back through *C*. The rapidity of the circulation can be increased by introducing the feed-water at *D*. The case often occurs that the water in one part is lighter, because it is a mixture of steam and water, as represented by fig. 2, and the hydrostatic law seems at fault, for it is independent of the hydrostatic pressure on the cross-section; so the circulation of the water will be maintained by the generation and the movement of the steam.

A strong and regular circulation of the water is an essential feature for the proper action of water-tube boilers. It protects the tubes, which are subjected to high temperatures, from burning, it equalizes the temperature and the expansion of the whole boiler structure, and the result is that the generation of steam is raised to the highest possible point. The circulation of the water ought not to be injured through the choice of the sectional area of the tubes. The higher the temperature and the greater the corresponding length of the tubes, just so much the larger must the cross-section of the same be made, otherwise the tube, on account of an insufficient circulation of water, will only deliver a stream of steam.

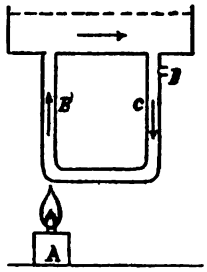


Fig. 1.

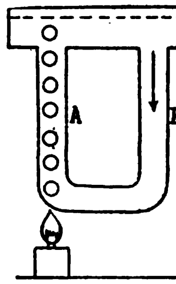


Fig. 2.

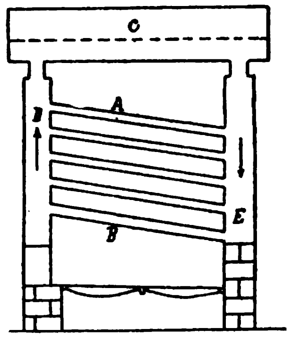


Fig. 3.

The form of boiler given in fig. 3 shows that if the sectional area of the tubes at *A* is sufficient for the circulation of the water, then that at *B*, where a higher temperature exists, will be insufficient. The result is that the tubes are overheated, and this has actually occurred in many miscalculated water-tube boilers. On the other hand, it is a further requirement from the standpoint of safety, that the sectional area of the tube should not exceed a certain amount in order that the average tubes can be run to advantage. It is upon these grounds that the diameters of water tubes for the different types of boilers used on vessels of war vary between the wide limits of 1 in. and 4 in., while the boilers for vessels engaged in commerce are usually fitted with tubes of the larger area.

The tubes that are used are, for the most part, seamless and of steel, but copper and brass are also employed. In long boilers with a forced-draft service wide variations of temperature are unavoidable in certain parts of a marine boiler, causing, especially in boilers of large diameters, marked expansions and contractions of the parts which form a frequently recurring source of leakages and damages. This is especially the case where the flame impinges against the fire-tubes. The recently adopted method of using ferrules as a protection for these joints is merely a palliative, as it has no metallic connection either with the tube or the tube-sheet, and, therefore, it soon becomes heated to a glowing temperature and burns away.

A similar attachment has also been applied to water-tube boilers, but with the difference that the tubes are subjected to an internal pressure, and that the connections must be placed in such a position that they are protected from the direct action of the flame.

As for the present construction of water-tube boilers, we find that we must thank the French engineers for the advances which they first made along these lines, for they have already made a successful application of boilers of this class to their vessels, and have led the navies of other nations in the application.

It is, of course, self-evident that special types of water-tube boilers must have been developed for the different types of vessels. Especial attention must necessarily be paid to their construction and their performance, in so far as they are to be adapted to particular services, and they must not be regarded solely from the standpoint of their general adaptability to all sorts of work. In order to specify two extreme cases, a boiler which would be thoroughly well fitted for application to a battleship would be of no use whatever on a torpedo-boat.

Viewed from this standpoint, it is possible to classify all of the water-tube boilers that have thus far been brought out into four groups, according to the location and shape of the tubes that are used. These groups are:

a. Water-tube boilers with straight and level tubes.—This group comprises the Perkins, Belleville, Palmer and Herreshoff boilers.

b. Water-tube boilers with straight and inclined tubes.—These are the Root, Watt, Belleville, Yarrow, Oriolle, Lagrafel D'Allest, Sampson, Durr, and Niclausse boilers.

c. Water-tube boilers with bent tubes.—Of such are the first Belleville boilers, the Rowan, Ward, Du Temple, Normand, Thorneycroft, Yarrow, Babcock & Wilcox, Wilson and Gleming & Ferguson boilers.

d. Water-tube boilers with spiral tubes.—These include the Herreshoff, Hohenstein, Bellis and White boilers.

As early as 1879 the French despatch boat *Le Voltigeur*, of 1,000 I.H.P., was fitted with Belleville boilers. After a satisfactory service of the boilers for a period of about three years no repairs were required. The French Admiralty has up to the present time applied the Belleville boiler to vessels of all sizes and kinds, including among the gunboats the *Crocodile*, of 450 I.H.P.; the *Active*, of 400 I.H.P.; the *Léger*, 2,200 I.H.P.; the *Lévrier*, 2,200 I.H.P.

It has also been applied to the cruisers *Milan*, 3,800 I.H.P.; *Alger*, 8,000 I.H.P.; *Hirondelle*, 2,100 I.H.P.; *Rigault de Genouilly*, 2,100 I.H.P.; *Latouche Treville*, 7,400 I.H.P.; *Chaney*, 7,400 I.H.P.; *Charner*, 7,400 I.H.P.; *Bruix*, 8,500 I.H.P.; *Descartes*, 8,500 I.H.P.; *Pascal*, 8,500 I.H.P.; *Galilée*, 6,500 I.H.P.; *Catinat*, 9,000 I.H.P.

In addition to these it has been put upon the coast defense ship *Tréhouart*, of 7,500 I.H.P., and the battleships *Brennus* and *Bouvet*, of 14,000 I.H.P. each.

In the Russian Navy water-tube boilers of the Belleville type are used in the armored gunboats *Grozjasciji*, *Gremjasciji* and *Otvaznji*, of 2,000 I.H.P. each, also in the royal yachts *Marevo*, of 200 I.H.P., *Standart*, 15,000 I.H.P. and *Ckarevna*, 800 I.H.P., as well as in the armored cruiser *Minin*, of 6,000 I.H.P.

In the English Navy the Belleville boiler has proven itself satisfactory in the *Sharpshooter*, of 3,500 I.H.P., and it has also been applied in the new first-class cruisers *Powerful* and *Terrible*, of 25,000 I.H.P. each.

Referring to the merchant marine, we find that as long ago as 1871 the Lagrafel boiler was used in the steamer *Isère*, and the same type of boiler was applied to the steamers *Blidah* and *Medea* in 1873, remaining installed in these vessels up to the present day.

In 1874 Lagrafel boilers were set in the steamers *Paoli* and *Saphis*, remaining in service until the sinking of these ships at the end of seven and eleven years, respectively. These same boilers were applied to the steamships *Colon*, *Cabile* and *Caid* in 1874, 1875 and 1876, respectively, and remained in service for many years.

The steamer *Liban*, built in 1882, was rebuilt in 1891, and had Lagrafel D'Allest boilers put in her. The *Dom Pedro* was reconstructed in the same way; the first of these being engaged as a general tramp, while the latter made regular trips between Europe and South America.

In 1884 the steamer *Ortegal*, of 1,800 I.H.P., belonging to the Messageries-Martimes Co., was fitted with compound engines and the Belleville boilers. The steamer *Sindh* (2,400 I.H.P.), belonging to the same company, had had a new set of boilers of the same kind put in her many years previously.

* Paper read before the Wissenschaftlichen Verein der k. und k. Kriegsmarine.

The same type of water-tube boilers have been put in the newest and largest ships of this same company—namely, the *Australien*, *Polynesien*, *Armand Behic*, *Ville de la Ciotat*, of 7,000 I.H.P. each, and the *Ernest Simons*, of 5,600 I.H.P.

The steamer *Mitidjah* is fitted with the Oriolle boiler.

The English steamer *Nero*, belonging to F. Willson & Sons, of Hull, has the Babcock & Wilcox boiler.

The *Friant*, *Charles Martel* and *Elan*, of the French Navy, as well as several steam yachts, have the Niclausse type of boiler.

The White water-tube boiler has also given satisfactory results in an English vedette boat.

DESCRIPTION OF SOME TYPES OF WATER-TUBE BOILERS.

I. The Babcock & Wilcox boiler, as it is built by the firm of the same name in New York and Glasgow, is shown in figs. 4–6, and is the type of boiler used on the steamship *Nero*

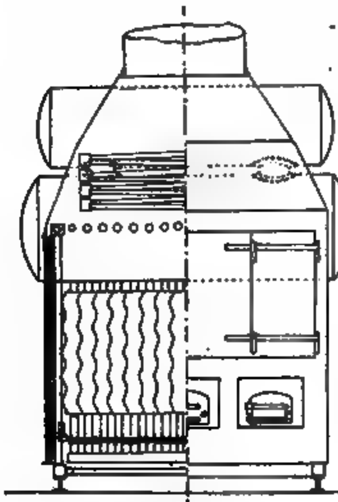


Fig. 4.

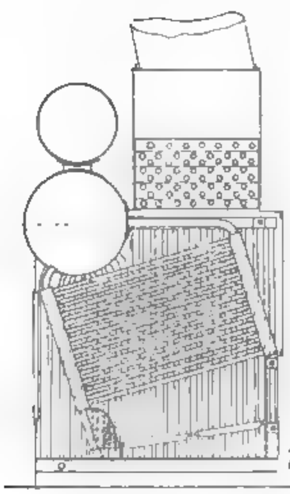


Fig. 5.

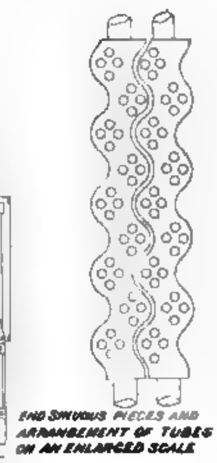


Fig. 6.

THE BABCOCK & WILCOX BOILER.

In this case the working pressure is 200 lbs. per square inch, yet the construction is so substantial, as far as strength sufficient for safety is concerned, that there is nothing to prevent the construction of boilers of this type capable of working under a still higher pressure.

The boiler is constructed of two different nests of tubes, in which a separate circulation of water is maintained. One of these nests of tubes is located directly over the grates, and is a modification of the water-tube boiler made by the same firm for stationary purposes. It consists of a number of pairs of front tubes of sinuous shape, which are connected with each other by means of separate groups of tubes, as the lower portion of figs. 1–4 would indicate. These groups of tubes of four each can be readily removed through the hand-holes. The stationary boilers of this make have, instead of a group of tubes, a single tube of a somewhat larger sectional area.

Over this nest of tubes, and like unto the outer shell of a boiler, there lie two cylindrical steam chambers, of which the upper one contains steam only when the boiler is in service, while the lower one is half filled with water and steam.

All of the front tubes open with free communication into the lower steam chamber, while those at the back communicate at their lower end with a common mud drum, which is fitted with a blow-off cock. While the boiler is in service the water flows through the inclined tubes and enters as a mixture of steam and water into the front tubes, and is delivered by them into the upper connecting pipes into the lower steam chamber, where the water and steam separate. In like manner there is an outflow of cooler water from this lower steam chamber or drum into the tubes at the back.

The second system of tubes consists especially of a number of vertical tubes, which likewise form a portion of the collateral boiler arrangements. The lower ends of these tubes are fastened into two four-cornered horizontal tubes, while their upper ends either run directly into the lower steam drum, but always below the normal water-level, or open into two other horizontal tubes, which are in turn led into the same steam drum, but always below the normal water-level. The water circulation in this system of tubes is such, that the water which is heated in the vertical tubes rises and flows into the steam drum, either directly or through the intermediary of the upper horizontal tube, while it leaves the drum through three or four tubes at the back of an equivalent sectional area.

At the front of the boiler there is still another tube which forms a part of the boiler framing, and is connected with this latter system of circulation. Over the boiler at the base of the stack a tubular heater is placed. This consists on one end of five and on the other of four end tubes, which are connected with each other by an equal number of straight tubes, wherein the water, which is delivered from the feed-pump, enters into the lower end tube or header at one end and flows through the connecting tubes to the other side, and thence back and forth till it enters the upper header, from which it is delivered into the boiler. In this header the water circulation is entirely mechanical or forced, and depends upon the running of the feed-pump. The heating surface of the heater is usually

Fig. 7.

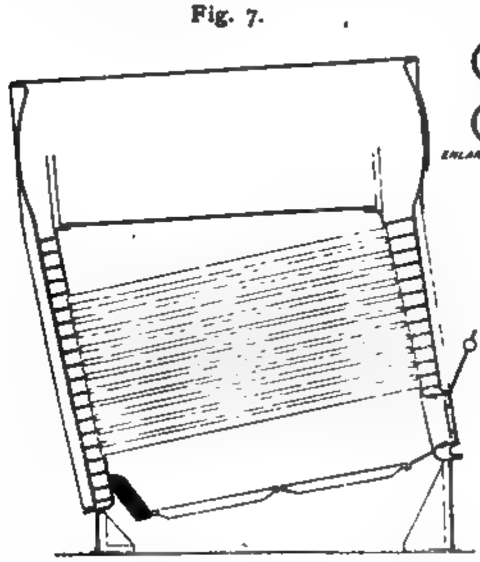


Fig. 8.

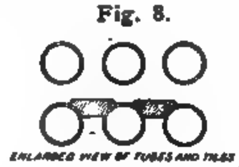
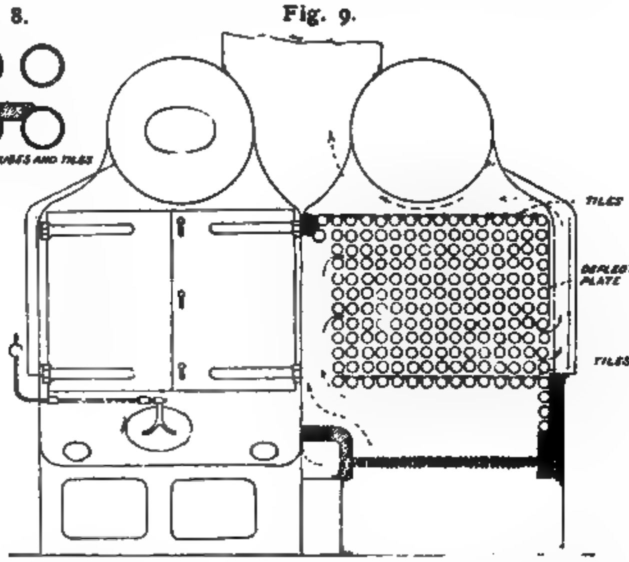


Fig. 9.



THE LAGRAFEL D'ALLEST BOILER.

one-sixth that of each of the boilers, and as it is the coolest part of the boiler, it is not to be supposed that the escaping products of combustion can be hot enough to raise this water up to the temperature of evaporation, so there is no generation of steam in the heater, but this first occurs in the boiler itself.

The tubes used in the nest that is located directly over the fire in this boiler have an internal diameter of $1\frac{1}{4}$ in., and a length of 7 ft.; the side vertical tubes are 3 in. diameter, are spaced 5 in. apart from center to center, and are about 9 ft. long, while the tubes in the heater are 3 in. in diameter and are approximately 7 ft. 6 in. long. The side construction consists of 3 in. of strong mason work supporting the vertical tubes, and $\frac{3}{4}$ in. of strong insulating material made of asbestos sheets bound together with lead cement.

The front and back consist principally of doors, which give access to the end tubes and their numerous hand-holes.

Three fire-doors are usually provided for the stoking. The grate surface is either one common surface, or is divided by fire-brick walls into three parts with a door for each part, an arrangement that permits of a more satisfactory handling of the fire.

A peculiarity of these boilers consists in the fact that the tube connections are simply rolled or expanded connections, and that no screwed stay tubes are used. By avoiding different thicknesses in the shells of the tubes, such a boiler will be protected from the strains that would result from variations of temperature and the consequent unequal expansion. The construction guarantees perfect tightness as well as strength for all ordinary services. The tubes of a square section are also connected to each other in a characteristic manner; it is done by round openings into which the tube body is fastened by rolling.

The hand-holes arranged for the rolling of the tubes must be so designed as to be closed by some simple device. Their caps are removed outwardly so that the pressure tends to push them off. The tightness of the cap is assured by the arrangement of the bearing surface without having recourse to a packing material. The strap on the boiler is held by bolts, it is made in one piece, and so formed that should a bolt break and the cap fall only a slight leak would be the result, and a great quantity of steam and water would not issue forth. The importance of such a detail in the construction is very important, when we consider that in a boiler of ordinary size there are more than a hundred of such caps.

II. The Lagrafel D'Allest boiler (figs. 7–9), as it is at present built by the firm known as the Forges et Chantiers de la Mediterrannée and the Fraissinet Company, of Marseilles, has a certain internal likeness to the Babcock & Wilcox boiler.

The boiler consists of two water legs, which are connected with each other by a number of inclined water tubes lying directly over the fire. These water legs are formed of two flat sheets which are held together by numerous stay-bolts, and they are closed at the bottom and sides, while at the upper ends they are open into a steam drum of cylindrical form.

In the construction of this boiler there are as many openings in each water leg as there are tubes, and the holes in the outer sheets are larger as the diameter of the tubes may demand. The tubes are fastened in the tube-sheets by rolling and expanding, which is done through the openings in the outer sheet. The openings in the outer sheets are closed by coverings whose lids lie inside the boiler, and which are held in position by bolts and yokes; the joints are made by asbestos and a soft copper wire. The boiler has no stay tubes; the water legs, which are connected at the top through the steam drum, need no further bracing at this point, and the connection of the remaining parts is effected by friction through the rolling out of the tubes in the tube-sheets.

The tubes that are ordinarily used have an inside diameter of about $2\frac{3}{4}$ in., a thickness of $\frac{1}{8}$ in., and are spaced 4 in. from center to center. Servé tubes are used in the lower rows.

While in service the water-level is maintained so as to cover the bottom of the steam drum, and the circulation of water is kept up by the water, which is heated in the tubes, flowing out into the front water leg as a mixture of steam and water, and thence rising directly into the drum. The water that has thus arisen spreads out over the bottom of the drum and flows down through the back leg, from which it is received into the tubes.

The arrangement of the course of the products of combustion in this boiler varies somewhat from that found in other boilers of the water-tube type. These boilers are usually set up in pairs near each other, and the combustion chamber of the two is a common space located between the two nests of tubes. Yet each boiler is fed separately and has a distinct circulation of water of its own. The bottom row of tubes is raised about 3 ft. above the surface of the grate. In order to prevent the gases of combustion from passing between the interstices of the bottom row of tubes, simply formed tiles are laid over and upon them, and a similar layer is placed on the top row. The spacing of the outer vertical row is also closed for about two-thirds the height from the top by sheet metal shields.

The design is very clearly shown in fig. 9, wherein the directions indicated by the arrows show the course that the gases of combustion must follow. They will be seen to pass beneath the bottom row of tubes into the common combustion chamber, thence sideways through the nest of tubes and then to spread out over the bottom of the drum.

This arrangement is the result of an attempt to obtain the most perfect combustion possible, by remembering that the direct rising of the distilled gases through the interstices of the nest of tubes would subject them to such a cooling temperature that the unburned gases could not unite with the oxygen.

The interior cleanliness of the tubes and water legs can be easily maintained through the numerous openings in the latter. A damaged tube can either be plugged or cut out and replaced.

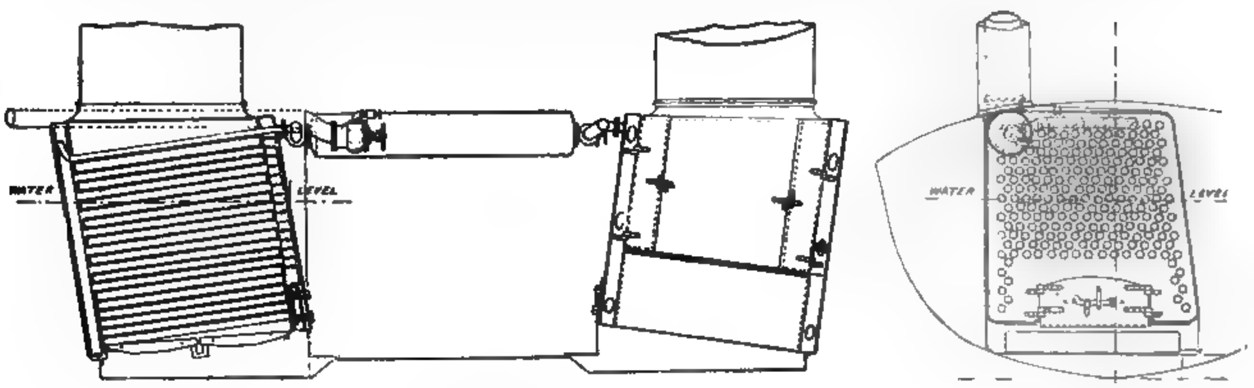


Fig. 10. Fig. 11.

THE ORIOLLE BOILER.

III. The Oriolle boiler (figs. 10 and 11), as built by the Messrs. Oriolle at Nantes, resembles the Lagrafel boiler in that it consists of two water legs which are connected to each other by a number of straight tubes. Only one of these legs, however, is in communication with the steam drum, and that is through a pipe. The tubes are located directly over the fire, and only single tubes are ranged along the sides of the furnace, as is done with the Lagrafel boiler. The rows of tubes are staggered, so that a tube is placed over the spacing of the row beneath. The gases which rise from the fire through the spaces in this nest of tubes accomplish a greater heating effect by this arrangement than would be the case were the tubes placed in vertical rows. The course of the draft reminds one of that of the Lagrafel boiler in its older form.

While in service the water-level is kept below the top of the upper row of tubes. The water, therefore, flows out from the lower row of tubes into the front water leg and upward in it to the water-level and then back through the adjacent tubes to the leg at the rear.

The tubes that are used are 3 in. in diameter. The circula-

tion should be brisk, and no deposits would be formed even though impure water were used in service. Nothing but steam is contained in the upper tubes while the boiler is at work, and this steam is here superheated. As these tubes have only a slight heating efficiency as compared with the tubes that are filled with water, it follows that they burn out sooner than the latter.

IV. The Yarrow water-tube boiler (fig. 12) also consists of two water legs, which are connected with each other by a nest of straight tubes and opening into a cylindrical boiler shell forming a steam drum. The water tubes extend even through outer sheets of the water legs, and are fastened in each of the four sheets by expanding, which is done with a simple machine. The tubes that are used are made of iron, are 1¼ in. outside diameter, and are cut with slots at that point which lies within the water leg; their ends are closed with a simple screw plug. The water circulation in this boiler is exactly the same as that of the Lagrafel D'Allest boiler.

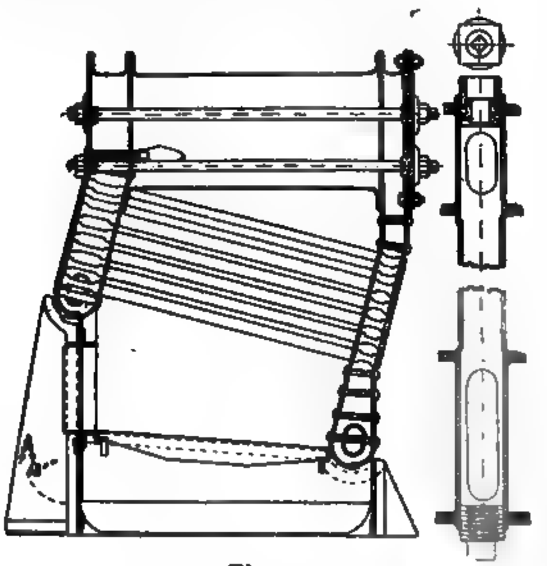


Fig. 12.

THE YARROW BOILER.

V. The Belleville boiler (figs. 13–16) consists of a series of nests of tubes, which are arranged near each other over the fire and are enclosed by a wall of heat-insulating material. Each nest of tubes, which is called an "element," contains a number of straight tubes which are arranged in the form of a compressed spiral. The tubes are screwed into forged connections. The connections between the elements are arranged vertically the one over the other, and so located that the upper end of one tube lies on the same level as the lower end of the next tube The connecting pieces or heads at the front end have two openings through which the opening of the tube can be examined or the tube cleaned. With these facilities an internal inspection can be made with an electric lamp, which is fastened on the end of a stick for the purpose and run down into the tube. A simple hand-hole plate with a yoke and screw is used for closing this opening. All of the tubes are slightly inclined. For war vessels tubes of 3 in. diameter are ordinarily used, but for other vessels the diameter of the tubes is usually put at 5 in The thickness of these tubes is usually ½ in. for those in the upper rows and ⅜ in. for those in the lower.

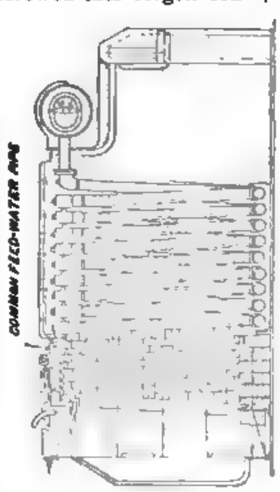


Fig. 13.

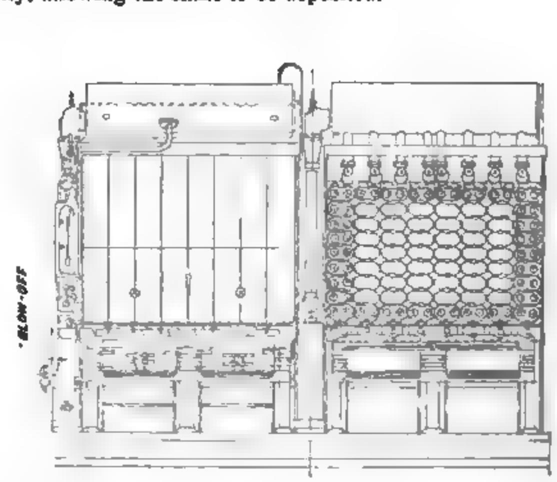


Fig. 14.

THE BELLEVILLE BOILER.

At the front end each element is brought into direct connection with the common feed-water pipe by means of the bottom head, and, at the top, it is connected in a similar way by the top head with the outer half of the boiler-shaped vessel forming the steam drum. Furthermore, the steam drum communicates through system of piping laid in its bottom and outer half of its shell with a horizontal water-pipe. It is in this system of piping that the water for the boiler is purified. The feed-water is delivered into the steam drum on the side opposite to that from which the circulation pipes are led off.

While in service the water-level is kept somewhat above the bottom of the drum, and the circulation of the water flows through each element successively—that is, out of the common horizontal water tube down to the bottom tube, into which latter the water flows and is heated, so that it passes through the back connection as a mixture of steam and water into the tube lying above it, where more steam is generated, and this continues from one to the other. Through each tube of an element there, therefore, streams not only the steam that has been generated in the tubes that lie below it, but also that which it has itself produced. Out of each element there pours a mixture of steam and water, which is finally separated in the drum by a perforated plate construction. There on the common bottom the hot water mingles with the incoming feed-water, and flows out through the circulation tube into the feed-water purifier and from this into the common horizontal water-pipe, whence it again passes into the circulation through the elements.

The fact that the steam generated in the lower tube is compelled to pass through those at the top, increases the rapidity of the circulation of the water over that which we have found in other water-tube boilers where the steam flows directly from each tube into the drum. On the other hand, the speed of the circulation suffers a marked diminution through the manifold changes of direction due to the course which it has to follow in passing from one tube to the next.

The feed-water purifier is a peculiarity of this form of boiler; the addition itself is dependent upon the method of handling the feed-water, and has been developed as the result of practice.

It is a well-known fact that, in spite of the greatest economy in the consumption of lubricants, and in spite of the passing of the feed-water through separators, that it will take a certain percentage of fats and salts from the upper surfaces of condensation which is deposited upon the heating surfaces of the boiler, where it gives many causes of anxiety.

In service these boilers are served with small doses of lime-water in attenuated solutions. It mingles with the feed-water delivered by the pump into the drum, flows over the whole length of the bottom before going out into the circulating tube, and mingles with that mixture of steam and water rising from the elements, so that it is quickly raised to the boiling point. As a result of this sudden raising of its temperature, all of the lime-salts as well as that brought in by the feed-water, together with the lime of the lime-water, which is straightway separated, is precipitated in a powdered form, and mixing in this finely divided state with the oily particles present in the feed water is carried into the feed-water purifier, through which the water for the boiler flows at a low velocity, allowing the slime to be deposited.

Investigations have shown that this process is very perfectly carried out, and that the heating surfaces remain clean; even though sea-water is used as a source of supply for wasteage, the heating surfaces show no signs of deposits, while in the purifier a thick slimy deposit will be found.

This method of handling the feed water with lime has also been used in the working of the Lagrafel D'Allest boilers, wherein 4 lbs. of lime was used each 24 hours per 1,000 I.H.P.; yet with this boiler the separation from the feed-water before coming in contact with the heating surfaces was not successful, and the deposits were found chiefly at the lower portion of the back water leg, where the water is most quiescent.

All the connections of the Belleville boilers are made with screws. The tubes are screwed into the back heads and the connection strengthened by check nuts lower down. The front heads have a slip joint, with threads in which the end of the tube is screwed, and where it is held by a check nut. It is only at the tube ends that the flame impinges against a double thickness of metal.

The simple manner in which the repairs of this boiler are provided for deserves to be followed out, for a boiler can be cleared of any desired element by slacking off the fastenings of the upper and lower surfaces, when it can be drawn out into the fire-room. Any desired tube in this element can then be removed, by taking off the unscrewed ring piece which connects it with the front head and slipping the tube out of the back head, from which it has been unscrewed. A new tube with a new ring piece can then be put in and the element put back, so that the boiler can be filled and under steam again in about six hours, so that all the work of a machinist with the help of the fireman can be dispensed with.

(TO BE CONTINUED.)

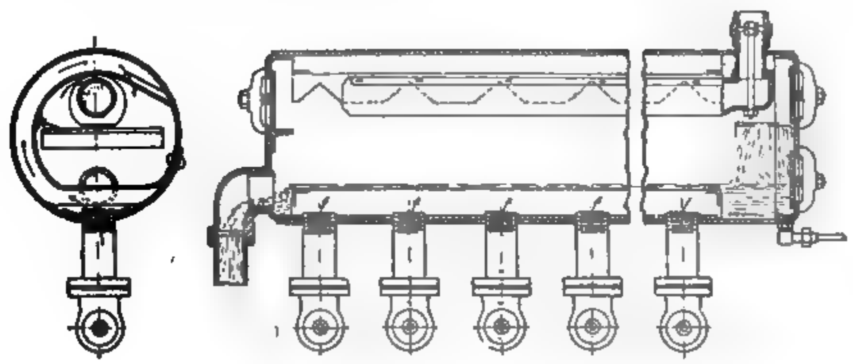


Fig. 15.

STEAM CHAMBER OF THE BELLEVILLE BOILER.

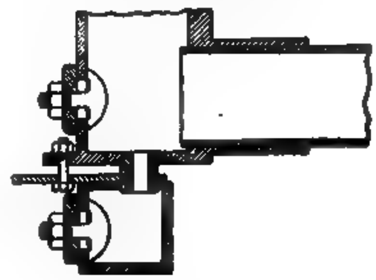


Fig. 16.

COMMON FEED-WATER PIPE.

FREE LABOR AND TRADE UNIONISM.

In the annual report of the executive of the National Free Labor Association, presented at the annual conference held in October, some statistics are given concerning the present position of free labor in Great Britain. It is stated that up to the end of August last no fewer than 228,000 seamen had been registered as free labor men, and a large number of these were known to have previously belonged to "Wilson's Union." In the metropolitan docks the demand for free labor tickets has been so great that it has been necessary to limit their issue according to the actual number of men for whom employment could be found. "The aggressive attitude of Messrs. Burns, Mann, Tillett and Wilson, with their 'new unionism,' has," the report proceeds, "resulted in their utter defeat, and has converted Southampton, Plymouth, Cardiff and Dublin, as well as Hull, into free labor ports." Discussing the present strength of the trade unionists, the report says that out of 9,786,073 male persons of 20 years of age or over who are working for their living in the United Kingdom, only 1,109,014 are members of trade unions, leaving 8,677,059 to be described as free labor men, non-unionists, "blacklegs," "scabs," "knobsticks," or anything else but trade unionists. Since the great dock strike "persistent and cruelly unjust efforts" have been made to force unwilling men to join the trade societies, many of which are run on purely party grounds or to further the socialistic schemes of the union leaders. "But what success," the report continues, "has attended the efforts of Mr. John Burns? The voluntary and compulsory additions to trade unions between the 1891 and the 1892 returns left a total of 18,000 less than the desertions. The numerical strength of the unions has gone back in spite of his great efforts, and confidence in the management of the agitators and self-seekers has been shaken among those who remain true—voluntarily, or under dread of the consequences. We believe in the need of combination, but not in the 11 per cent. being allowed to coerce 89 per cent. of the workmen of the country." The report also deals with the question as to what effect trade unionism has on the trade of the country, and on this point it says: "The value of fixed capital laid idle by the strikes in various trades during 1891 amounted to £9,498,000. But the most fearful indications of the evil wrought by strikes which occurred in 1891, 1892 and 1893 are shown by the exports from Great Britain during the three quarters of each of those years ending September 30. The totals were: In 1891, £187,475,-896; in 1892, £170,480,788; in 1893, £165,898,621, or a difference of nearly £22,000,000 between 1891 and 1893." Notwithstanding this diminution in production the bill of the nation for food and drink imported has, the report adds, not stood still or diminished, but, on the contrary, has increased, and Great Britain has been paying this bill, not out of income from material produced, but out of capital.

MANIFESTO OF THE NATIONAL FREE LABOR ASSOCIATION.

Evidently there is rebellion against the trade unions in Great Britain, as is shown by the following manifesto, dealing with the recent Trade Union Congress, has been prepared by the National Free Labor Association, and which the *Times* said a short time ago will be issued in the course of a few days:

"After the series of ridiculous farces enacted at the late Trade Union Congress at Norwich, we invite your attention to the policy now entered upon by the leaders of the 'new' trade unionism, and ask you to compare their wild theories with the sturdy common sense of the well tried and veteran labor leaders who have served you so well in the past.

"At the recent congress at Norwich the following resolution was actually passed:

"'That, in the opinion of this congress, it should be made a penal offense for an employer to bring to any locality extra labor when the existing supply was sufficient for the needs of the district.'

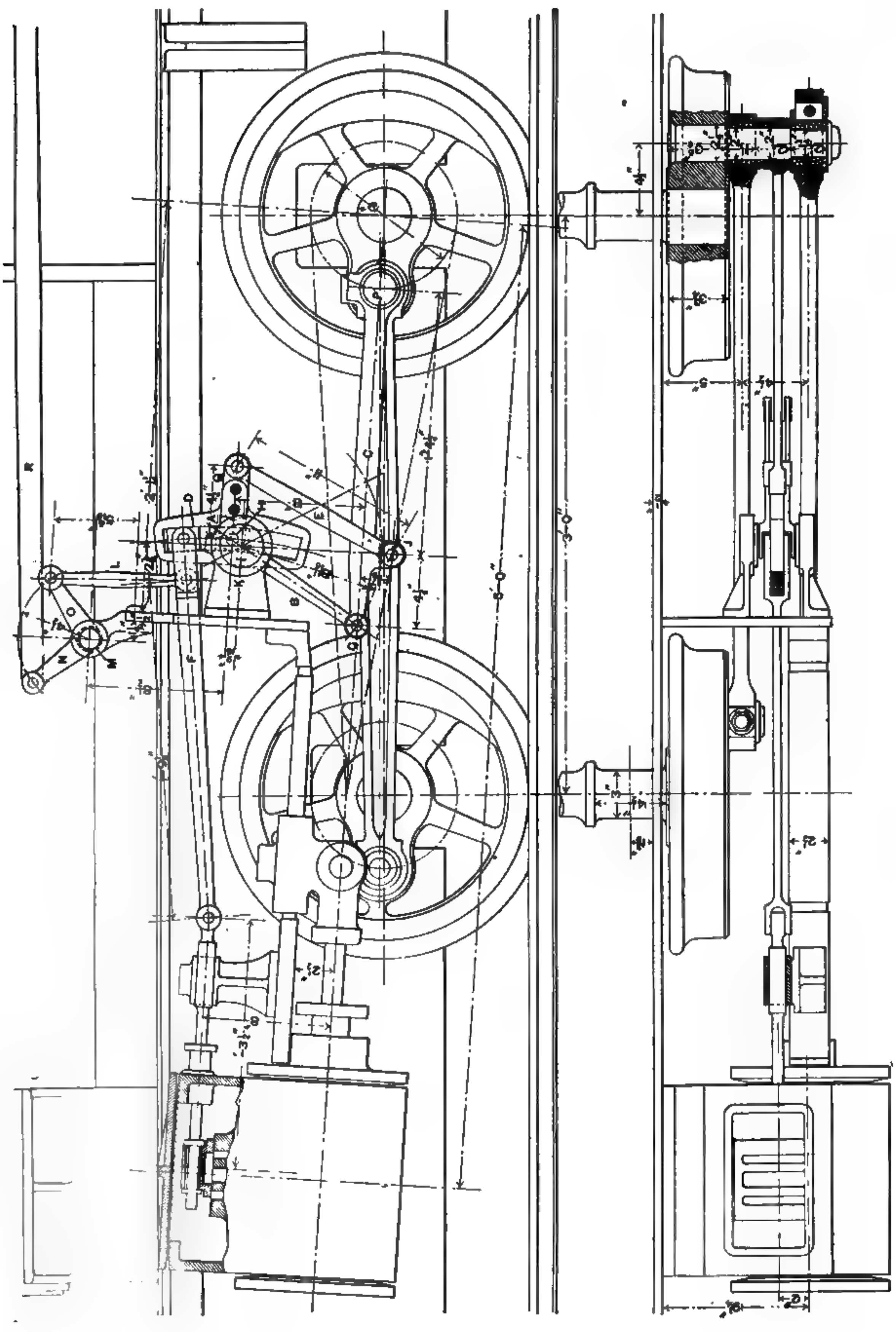
"Now, we ask you to consider the full meaning of this insolent demand. (*a*) It means that no employer will be able to give you work unless you belong to a trade union. (*b*) It means that no British workman shall be free to work except he receives the precious permission of the trade union officials. (*c*) It means that an insidious attempt is being made to coerce you into joining the trade unions.

"But that is not all. The congress, which professed to have for its object the freedom of labor, has a curious idea of that policy, for it resolves to urge upon the Government the advisability of reintroducing the Employers' Liability Bill, with the clause which forbids workmen to make better terms with their employers than the law courts would enable them to do.

"Fellow-workmen, we do not think you will call this freedom; we think you will call it tyranny, and that, too, in one of its worst forms.

"Has now every workman the right to make terms with his employer as to insurance against accidents? We think you will say, 'Yes, undoubtedly;' but the trade union officials say, 'No; let us destroy these mutual insurance societies in order that we may wield more power over the destinies of their members;' and we therefore maintain that a congress of trade union officials which advocates the passing of a measure forbidding 'contracting out,' has no right to profess to champion the rights of labor, but that it has grossly misrepresented the opinions of the vast majority of the working classes.

"Evidently wishing to cap these demands with something more ridiculous still, the congress passed a resolution affirming



BAGUELEY'S VALVE MOTION.

the desirability of nationalizing, not only the land, mines, and railways, but all the means of production, as if there were the slightest chance of this wild dream ever being realized; if newspapers had been included in the list of things the congress wished to nationalize, would not there have been a tremendous outcry raised by those journals which are at the present moment engaged in supporting these trade union officials, and yet there is far more sense in the theory of nationalizing the press than in that of nationalizing the land and its minerals."

BAGUELEY'S VALVE-GEAR.

The full-page engraving herewith represents a very ingenious and simple valve-gear, which is the invention of Mr. Ernest E. Bagueley, of Stafford, England. To readers who are familiar with the principles of the link-motion and "radial" gears, the operation of the mechanism shown by the engraving will be obvious with little or no explanation.

The link A is suspended or supported by bearings H, which are journalled in an eccentric I attached to the pendulous lever B. This eccentric oscillates in the bearings K, and the lower end G of the link B is driven by the rod O, which is attached to the crank-pin P, or may be pivoted to the connecting-rod. The motion thus imparted to the lower end of B and to the eccentric I moves the link A in a horizontal direction opposite to that of the piston, an amount equal to the lead. The link A has a horizontal arm Q attached to its back side. The end of this is connected by another link E to the rod C, the vertical movement of which is transmitted to the end of the arm Q, which thus oscillates the link. This oscillation added to the lead gives the valve its required travel. The link is connected to the valve-stem by a block D and radius link F, which is raised and lowered by a tumbling or reverse shaft M in the usual manner.

The inventor says that "the link A is held in position by the rod E, the length of which is such as to have the error due to its end traveling in an arc corrected by the same movement of the end of the lever B, which gives the lap and lead movement. . . . The motion gives equal leads, port openings, and cut-off."

It is a very simple form of gear, and may be readily applied to the ordinary type of "American" locomotives, and it seems to have very decided merits.

THE BOW FIRE OF MODERN SHIPS.

The following interesting letter from a correspondent of the London *Times* has recently been published in that paper:

"As a broadly stated proposition, it is true of the modern British man-of-war that upon an object lying directly ahead of her she can bring to bear a smaller number of guns than can be brought to bear upon a similarly situated object by the modern foreign warship of corresponding class and less displacement. It is also true, as a general rule, that the British guns thus capable of firing right ahead are, although fewer, somewhat heavier, especially in battleships, than the foreign ones. Apparently it has been assumed by us that, so far as bow fire is concerned, superiority of caliber will compensate, at least to some extent, for numerical inferiority of pieces; and since, even in our latest designs, the principle has been persisted in, in spite of the fact that all foreign countries have adopted the diametrically opposite system, it is important, before we lay down any more ships, to inquire whether or not we are herein following a sound and defensible policy. For the proper consideration of the problem it is necessary to bear in mind certain axioms. One of these is that it is desirable, both because of the relative smallness of the target thereby exposed, and also because of the manœuvring advantages that are thereby retained, to fight as much as possible bows on. Another is that smaller guns can be fired with proportionately greater rapidity than larger ones. Another is that multiplication of pieces reduces the risk of the total disablement of the gun armament of a ship. And yet another is that, although a successful shot from a larger gun may be proportionately more destructive than a successful shot from a smaller one, it is easier to make accurate shooting with smaller guns than with larger ones; and that, not only on account of their greater facility of manipulation, but also on account of their greater rapidity of fire, smaller guns may be expected to make more hits than larger ones. From this it may easily result that in a given length of time a comparatively small gun may do more aggregate damage than a very large one, seeing that the small one is capable of getting rid of the greater number of projectiles, and possibly even of the greater weight of metal, as well as of making the larger proportion of hits. It is further necessary, in order to be able to weigh the question, to assess, at least roughly, the relative quickness of fire of the various classes of guns. It is probably fair to assume that, supposing each weapon to be ready loaded at the beginning of an action, guns can fire as follows, due attention being paid to aim, in a space of 3 minutes: Breechloaders of 10 in. and upward, two shots; of 8 in. and less than 10 in., three shots; of 6 in. and less than 8 in., four shots. Quick-firing guns of 6 in., 10 shots; of 4.7 in. and less than 6 in., 12 shots; of 3.9 in. and less than 4.7 in., 14 shots. In the comparisons which are to be made, guns of less than 3.9 in. (10 centimeters) caliber are not considered, as they do not pierce any formidable thickness of armor. The period of 3 minutes has been chosen as the unit for the purposes of comparison, since in 3 minutes two vessels approaching one another at a speed of 15 knots would reduce the distance between them from 2 miles to ½ mile. In other words, in that brief space of time they would traverse the whole zone in which, while the gun is most dangerous, the torpedo is absolutely harmless.

"Here, then, is a statement of what can be done by the bow guns of some typical modern ships in 3 minutes:

	Ships	Number and Nature of Guns bearing right ahead.	Bow Fire in Three Minutes. Number of Rounds.	Total Weight of Metal Thrown	Total Muzzle Energy Developed.
				Lbs	Ft.-tons.
Battleships.	*Royal Sovereign*, 14,200 tons (British)	Two 13.5-in. B.L.	4	5,000	140,921
		Two 6.0-in. Q.F.	20	2,000	68,340
		4 guns	24	7,000	209,260
	Charlemagne, 11,232 tons (French)	Two 11.8-in. B.L.	4	2,504	119,640
		Six 5.5-in. Q.F.	72	5,040	212,544
		Four 3.9-in. Q.F.	56	1,568	65,632
		12 guns	132	9,112	397,816
	Sardegna, 13,360 tons (Italian)	Two 13.5-in. B.L.	4	5,000	140,920
		Two 6.0-in. Q.F.	20	2,000	68,340
		Two 4.7-in. Q.F.	24	1,080	37,248
		6 guns	48	8,080	246,508
	Oregon, 10,231 tons (United States)	Two 13-in. B.L.	4	4,400	134,508
		Four 8-in. B.L.	12	3,000	89,976
		Two 6-in. Q.F.	20	2,000	64,080
		8 guns	36	9,400	288,564
	Renown, 12,350 tons (British)	Two 10-in. B.L.	4	2,000	57,720
		Two 6-in. Q.F.	20	2,000	68,340
		4 guns	24	4,000	126,060
	Jauréguiberry, 11,824 tons (French)	One 11.8-in. B.L.	2	1,252	59,820
		Two 10.8-in. B.L.	4	1,904	61,200
		Four 5.5-in. Q.F.	48	3,360	141,696
		7 guns	54	6,516	262,716
	Sissoi, 10,180 tons (Russian)	Four 12-in. B.L.	8	5,848	153,120
		Four 6-in. B.L.	16	1,168	33,280
		8 guns	24	7,016	186,400
1st Class Cruisers.	*Impérieuse*, 8,400 tons (British)	Three 9.2-in. B.L.	9	3,420	77,598
		Two 6.0-in. B.L.	8	800	19,392
		5 guns	17	4,220	96,990
	New York, 8,500 tons (United States)	Four 8.0-in. B.L.	12	3,000	89,976
		Six 4.0-in. Q.F.	84	2,772	84,000
		10 guns	96	5,772	173,976
	Dupuy de Lôme, 6,297 tons (French)	Two 7.6-in. B.L.	8	1,330	63,152
		Three 6.3-in. Q.F.	30	3,300	138,960
		5 guns	38	4,630	202,112
	Capt. Prat, (900) tons (Chilian)	Three 9.4-in. B.L.	9	2,853	84,690
		Four 4.7-in. Q.F.	48	2,208	93,112
		7 guns	57	5,061	178,002
2d Class Cruisers.	*A[illegible]a*, 4,360 tons (British)	One [illegible] in. Q.F.	1	1,00[illegible]	34,170
		[illegible] gu[illegible]	10	1,[illegible]00	34,170
	Chasseloup-Laubat, 3,722 tons (French)	Three [illegible] in. Q.F.	3[illegible]	3,3[illegible]	13[illegible],960
		Two [illegible] in. Q.F.	24	672	28,128
		5 guns	54	3,972	167,088

VIEW, LOOKING UP THE INCLINED PLANE AT BLOOMFIELD, N. J.

VIEW, LOOKING DOWN THE INCLINED PLANE AT BLOOMFIELD, N. J.

"Special notice is directed to the astonishing strength of the *Charlemagne*, *New York*, *Jauréguiberry*, *Capitano Prat* and *Oregon*.

"It will be seen that in every case the bow fire of the British ships, tested by this 8 minute standard, is weaker, not only in number of rounds, but also in weight of metal thrown and in total muzzle energy developed, than the bow fire of foreign ships of similar class and of about the same or of smaller displacement. The attention which, especially in France and the United States, has been devoted to the increase of end-on fire has hitherto passed almost unregarded here; but our disparity in this respect has now become so marked that we can no longer afford to disregard the subject."

THE INCLINED PLANES OF THE MORRIS CANAL.

In our issue for January, 1893, we illustrated and published a short description of the inclined planes that are in use on the Biwa Canal, in Japan, which were built under the superintendence of Mr. Sakuro Tanabe, of the Imperial University of Japan. At the time of the publication of the article we were not aware that Mr. Tanabe had visited this country as a member of a Japanese commission, to investigate the inclined planes in use on the canals of America, with the view of adapting them to Japanese services; but the fact is that this commission made a very careful study of the inclined planes in use on the Morris Canal, and it was from the drawings and memoranda obtained during this visit that the details of the planes on the Biwa Canal were prepared. Thus did we go abroad to learn the news of home.

It was at the close of the first quarter of this century, before the advent of railroads and when canal transportation still held the pre-eminent position as an economical method of transportation, that the charter was granted for the construction of the Morris Canal, that was to and did afford a cheap means of transportation for merchandise between the Hudson and the Delaware, and especially as an eastern outlet for the coal of Pennsylvania. To be exact, the charter for the construction of this canal was granted on December 31, 1824, and in the following July ground was broken and the work pushed to completion, which was accomplished six years later, in August, 1831—that is, the canal was finished through to Newark, but it was not until 1836 that it was carried through to Jersey City.

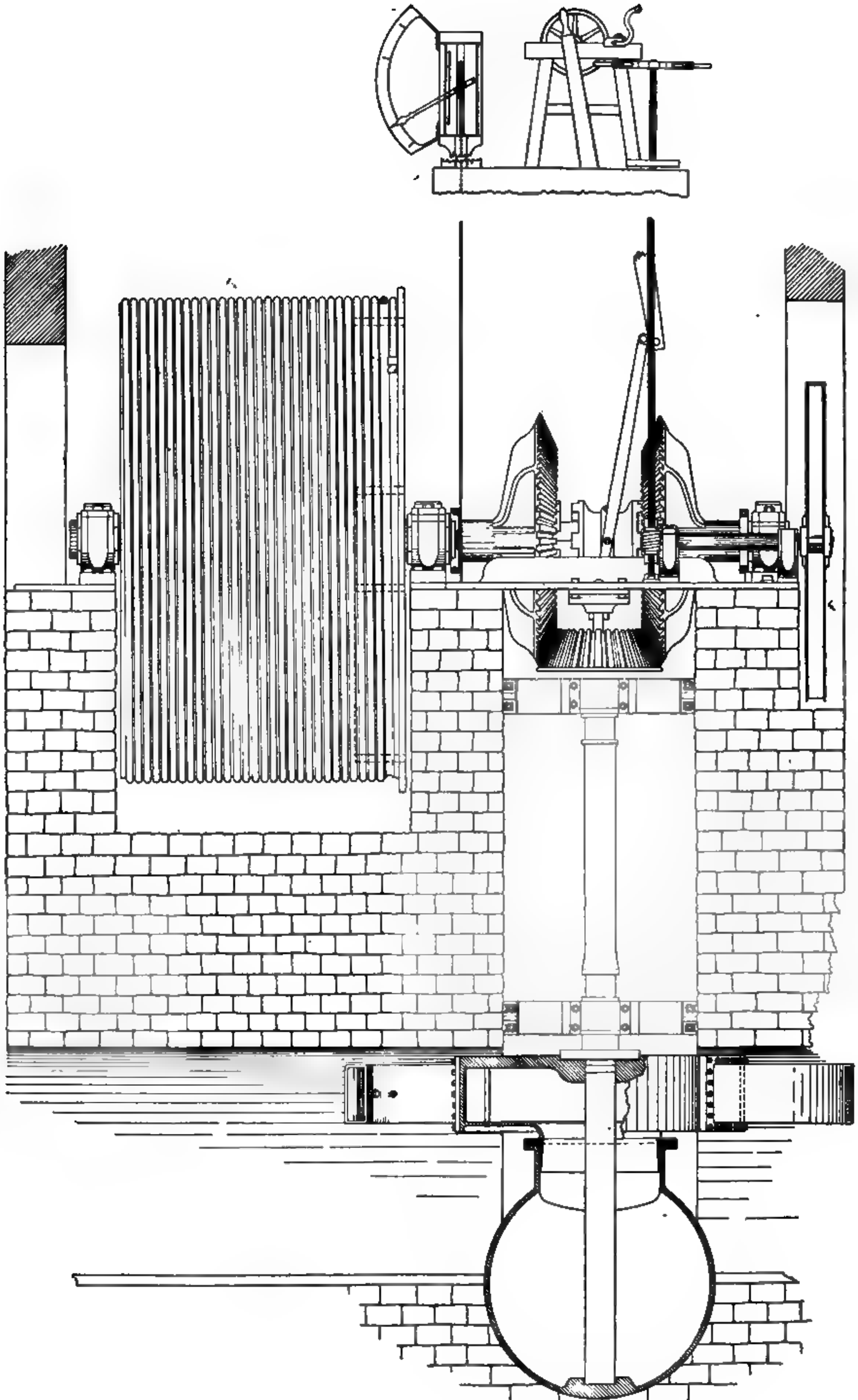
In these days of ship canals connecting widely separated bodies of water, the original Morris Canal was of Lilliputian dimensions. As first constructed the depth of the water was only 4 ft., in which boats of 18 gross tons capacity and drawing 3 ft. of water were floated. The breadth of the canal was 20 ft. at the bottom and 32 ft. on the water-line. The locks were naturally of corresponding dimensions, the chambers being 9 ft. wide and 75 ft. long between the miter sills.

Differences in level were overcome, then as now, by both locks and inclined planes, depending upon the lift between the two adjacent levels, but the planes were of the lock as well as of the summit type. There were 23 of these planes all told, of which three were of the lock type and 20 were summit planes. The difference is that the summit plane is one like that shown in our engraving, where the incline rises over the brow of the embankment at the end of the canal, and thence passing over it dips down into the water, while the lock planes end in the chamber of a shallow lock, into which the boat is run, and where, after the gates have been closed, water is admitted raising the level to that of the canal above.

This system was continued until the winter of 1835–36, when all of the summit planes were changed to lock planes. The probable reason for this was that an increase in the length of the boats was in contemplation, and there was a difficulty in carrying a solid boat over the brow of the incline on a single car. The canal remained in this condition until 1841, when the demand for better facilities and larger boats led to the widening of the planes by 2 ft., while the locks were widened to 11 ft. and lengthened to 95 ft. The traffic still continuing to increase, work on the general enlargement of the waterway was begun in 1845, when the breadth of the canal was increased to 25 ft. at the bottom, to 40 ft. at the water-line, and the depth of water made 5 ft. instead of 4 ft. At the same time the section boats, like those shown in our engravings, were first introduced, and these had a cargo capacity of 44 gross tons. These boats are really two separate vessels, but dependent upon each other in that one has the bow and the other the stern with the rudder. They are hinged together at the deck-line by heavy iron bars in a manner exactly similar to that shown on the half section of the car in our engraving. As these boats were of such a construction as to be easily carried over the brow of a summit plane, and as this style of plane is less expensive and troublesome to operate than the lock type, all of the planes west of the summit were rebuilt and converted to summit planes using wire ropes in the winter of 1850–51. The work was, however, begun in the winter of 1847–48, when plane No. 6, west, was so reconstructed. This work was followed at once by the remodelling of all of the planes east of the summit to similar arrangements, but the work proceeded more slowly, and it was not until 1860 that the last change had been made, although it had been commenced in 1852 and continued without interruption until completion.

This enlargement and change in the capacity of the canal was followed at once by the introduction of larger boats in 1860, when 70 gross tons was the limiting capacity. This

THE CREST OF THE INCLINE AT BLOOMFIELD, N. J., SHOWING BOAT LEAVING THE WATER.



SECTION OF POWER HOUSE OF INCLINED PLANES ON THE MORRIS CANAL.

rating has been only slightly increased since then, and the average cargo is now from 75 tons to 80 tons, with the boat drawing 4 ft. of water.

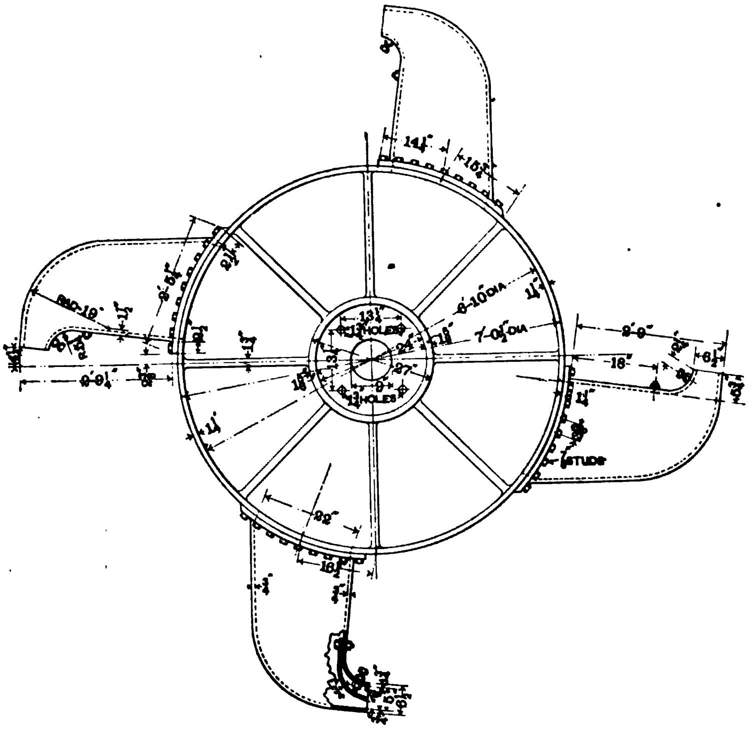
As we have already said, the canal starts from tide-water level at Newark and runs to Phillipsburg on the Delaware River. In traversing it a boat passes through 16 lift locks and over 12 inclined planes to the summit, which is at Lake Hopatcong. The elevation above the sea-level at this point is 914 ft., of which 156 ft. were gained in the locks and 758 ft. on the inclined planes. From the summit the drop to the Delaware River at low water is made by means of 11 inclined planes and seven locks, giving a total fall of 760 ft., of which 69 ft. is accomplished by the locks and 691 by the planes. This survey indicates that the Delaware at Phillipsburg is 154 ft. above tide-water. Water is supplied by the Ramapo, Pequonock, and Wyanock rivers, from Greenwood Lake, which is artificially raised 15 ft. by the canal dam, and from Lake Hopatcong, which is raised 11 ft. above its normal level by similar means. Then there are other reservoirs known as the Cranberry Reservoir, Bear Pond, and the Rockaway River.

At present the tonnage passing through the canal is from 1,500 tons to 1,600 tons a day, and the time required for the passage from end to end, a distance of about 75 miles, is in the neighborhood of four days, all boats lying to at night.

The engravings published on pages 554 and 555 are taken from photographs of the plane at Bloomfield, N. J. That on page 555, which is taken looking east from the end of the canal, shows the brow at the summit of the plane with the car and boat which have just come out of the water passing over the crest, one-half being on each incline. The whole length of the incline is shown by the two engravings on page 554, the photographs having been taken from the same point, one looking up and the other down. In one a boat is seen ascending the plane, and in the other the power-house, with the flume leading to it from the upper level, together with the ropes, are clearly shown. This plane is about 560 ft. long, with a lift of 56 ft., or 1 in 10, which is the average inclination of all the planes on the system. The machinery used for hauling the car is of the simplest description, and is interesting for that very reason. Water is used as the prime mover throughout on every plane, and the wheels are geared directly to the drum. In this the machinery at the inclines of the Biwa Canal, in Japan, differs from its American model, in that an electric motor is interposed between the wheel and the winding drum. The wheel, an engraving of which is given in plan on page 557, and in the section of the power-house on page 556, is of the simplest type of reaction wheels. Originally the wings were cast solid with the main body of the wheel, but as a slight breakage would cripple and destroy the whole wheel, the design shown in our engravings was adopted and is still used. The whole is of cast iron, and the nozzles are arranged with adjusting plates to fix the outflow and power in accordance with the head of water that is available. It is unnecessary to recapitulate the dimensions of the wheel as they are given on the plan, except the heights. The opening is 1¾ in. horizontally and 16 in. vertically. The total height of the wheel over flanges is 22¼ in. Water enters from below, and while work is being done it takes the weight off from the step that carries it through an auxiliary shaft resting on a step in the trunk, and in contact with a brass block 2 in. thick beneath the main shaft. The wheels are undoubtedly very wasteful of water in comparison with the amount of power that they develop, which, by the way, has never been measured; but as a certain amount of water is required to supply waste and the locks on the lower levels, it is as well to let it run through the wheel as idly through a flume, so that under the circumstances there is no occasion to economize.

The engraving on page 557 gives a clear idea of the arrangement of the machinery in the Bloomfield plane house. The drawing was made especially for this engraving from measurements taken on the spot, and is accurate except that the distance from the top of the water-wheel to the horizontal bevel gear should be about 8 ft. more than is here represented, which is put at 10 ft. 11 in., the shortening having been done to meet the exigencies of the space allowable for the engraving. This distance, however, varies with each plane. The shaft rising from the wheel is 9½ in. in diameter, and is keyed at the upper end to a bevel gear of 3 ft. outside diameter meshing in with two others, each 3 ft. 10 in. in diameter, the common pitch of the teeth being 2¼ in. These two vertical gears run loosely on the main horizontal shaft, being held in position by the bearing and collars, and furnished with an open clutch on the faces of the hubs opposite each other. Between the two a heavy clutch-head slides over a feather in the shaft, engaging one or the other of the vertical gears according as it is desired to turn the drum in one direction or the other. The clutch jaws are four in number, each 2⅜ in. deep, and with a face so that ¼ in. clearance is given between the back edge and that on the clutch of the gear. This clutch is shifted to and fro by the combination of levers shown in the engraving, the upper end of which projects above the platform in the upper story of the plane-house.

The shaft upon which these level gears run is of wrought iron 8 in. in diameter, and turns in boxes 12¼ in. long. On one end close to the wall of the building it carries a brake-wheel 8 ft. in diameter, with a face of 5 in. between flanges,



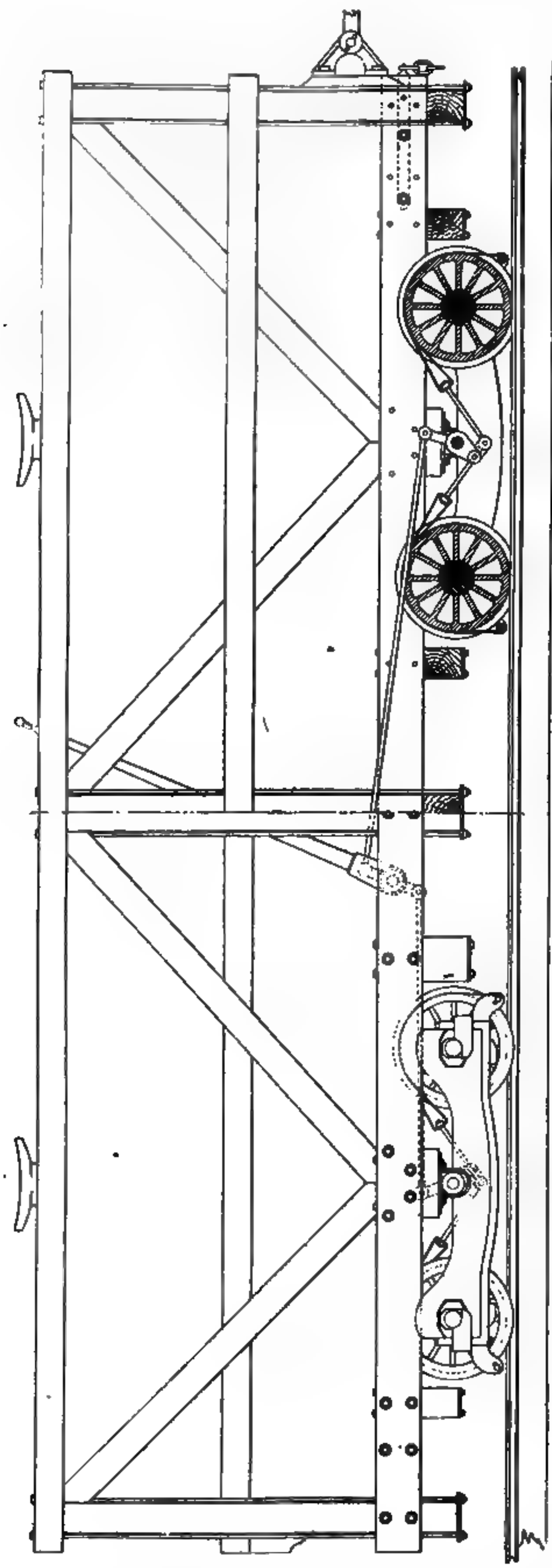
PLAN OF WATER-WHEEL USED AT THE INCLINED PLANES ON THE MORRIS CANAL.

1 in. deep and ½ in. thick. At the other end of the shaft there is a heavy pinion about 30 in. in diameter, with 23 teeth of 4 in. pitch and a face of 15 in. The brake-band that clasps the wheel is of ⅝-in. iron, and is operated by the hand-wheel shown on the upper floor, which turns the worm meshing in with a worm gear that rotates the tightening shaft of the brake-band. This brake is used for checking the speed of the car on its way down the incline, and for stopping it when it has reached the proper point beneath the surface of the water.

The pinion at the other end of the shaft meshes into the internal teeth on the winding drum, which is 11 ft. 8 in. in diameter, with a working face of 6 ft. 11 in., in which there are 31 grooves, each 1¼ in. deep, and carrying the rope that is 2½ in. in diameter and of steel. This drum is mounted on a cast-iron shaft 11 in. in diameter, swung in heavy bearings 12½ in. long.

For use in foggy weather there is a light level gear on the main shaft meshing in with a pinion on a small vertical shaft that operates an indicator, showing the location of the car at all times. The marks on the face of this indicator show the car in position beneath the water on the upper level, on the brow at the summit, and below water on the lower level. This, with the winding apparatus for raising and lowering the gate in the operating room, is all of the machinery in use. From the windows of the room a clear view up and down for the whole length of the plane is obtained.

The track upon which the car runs has a gauge of 12 ft. 5 in.,



SIDE ELEVATION OF ONE-HALF OF CAR USED FOR TRANSPORTING BOATS ON THE INCLINED PLANES OF THE MORRIS CANAL.

and is composed of two T-rails 3 in. high, with a head of the same width and a flange of 4 in., the web being 1 in. thick. These rails are laid on stringers of 8 in. × 9 in. timber set on stone foundations. The hauling rope runs up and down in the center of the track, and is supported by carrying pulleys in the ordinary way. Where it runs under water it passes over horizontal submerged pulleys for the necessary change in direction.

The rope, after leaving the drum, runs out of the house in both directions over the carrying pulleys, beneath the surface of the water, and to the car, where one end is rigidly and securely fastened to one of the cross timbers, while the other is attached to a drum that can be turned to take up any stretch that may occur.

The car, like the boats, is made in two sections, each 32 ft. long over the main longitudinal sills. Each section is carried by four two-wheeled trucks, giving eight wheels to each. The wheels have flanges on both sides of the rail, and are 2 ft. 5 in. in diameter. The truck framing is of cast iron. The main longitudinal sills are 12 in. deep, and on them a side framing of the form shown in the car engraving is built. This framing is 9 ft. 6 in. high, and is strongly braced to withstand side shocks; the detailed arrangement being clearly shown in the accompanying engraving, which shows, however, only one section, the other being coupled to it by the heavy bars at the right-hand end. The wheels of the car are also controlled by brake-straps passing over them and operated by the long lever. But in actual practice no use is made of them, as the speed is perfectly regulated at the plane-house.

Two men serve to operate the plane: one in the house and the other on the car. When a boat appears the car is run down into the receiving basin, and the boat floated over it between the frames. When in position lines are made fast to the cleats on the top of the side frames, a signal given by hand or by a horn at night and in foggy weather, to the man in the house who starts the machinery. The car tows the boat out, and rising up the incline, catches it and carries it to the other level, an operation requiring about five minutes of time. Some of the planes are double tracked, so that a boat can be transferred in both directions at once, but for the most part they have only a single track, like this one at Bloomfield, which may be considered as a typical example of what is done.

DISTRIBUTION OF ELECTRICAL ENERGY IN THE MILLS OF MESSRS. J. FORREST & CO., AT SAINT-ETIENNE.

We have from time to time called the attention of our readers to the rapid progress which has been made in the development of electrical power for driving factories and shops, where a motor is used for each individual machine, and shafting, with its accompaniment of pulleys and belting, is entirely dispensed with. The examples which have been mentioned in our columns have been the new shop of the Northern Railway of France and the Columbia Mills of South Carolina. Through the courtesy of *L'Électricien* we are enabled to present illustrations and a description of the method of distribution of electrical energy in the ribbon manufactory of Messrs. J. Forrest & Co., at Saint-Étienne, in France.

Applications of electricity are rapidly propagated in the industrial region of Saint-Étienne, which presents, as is well known, very varied aspects. In fact, side by side with the large establishments devoted to metallurgical operations and to the workings of iron and steel, are mills of an entirely different kind, where silks and fine ribbons are manufactured. Messrs. Forrest & Co. own one of these factories, which is remarkable for the general arrangement and for the application which has been made of electricity therein. Our inclination would be to enter into the description of this with great fulness, urged on by the interest in the subject, but unfortunately our limited space will not permit.

The factory employs 500 people. The principal building faces the Rue Buisson, and has an underground floor on the level with the textile shops and the Rue St. Michael, a ground floor and three stories above. It is connected by two wings to a central building raised one story. The shop has a length of 154 ft., and the breadth 115 ft. Its roof is of the serrated type. It contains 100 looms for special articles, quadruple and sextuple plushes and ribbons, all of which are driven by electric motors. Next to the weaving-room, and separated simply by a glass partition, there is the spinning-room, also driven by electricity. The west wing is devoted to taffetas and lusters; this wing serves also for a storehouse for silks and for sorting and dyeing.

There is also a finely appointed printing-office, where stamps and rolls intended for the ribbons are prepared. In the central building there is a mechanical warping mill, with horizontal warpers for plushes and heavy stuffs, covering a superficial area of 3,580 sq. ft. The four floors of the main building are successively occupied, starting from the first with the weaving of ribbons, velvets, manufacture of boxes, and the warping of ribbons; the winding of raw silk is also driven by

electricity. Then there is the storehouse for the cards of the Jacquard looms and the duplicate parts for the looms. When the building was completed, in 1891, the question of the mechanical installation of the machinery was given the most careful attention by the proprietors. Different projects were discussed. For some years the progressive development of the industrial applications of the electrical processes had been rapidly advancing; the perplexity was therefore less than it would have been earlier, and the advantage of the method of transmitting power to individual motors was a matter to cause considerable hesitation. The system which had been adopted up to that time consisted of running the line shaft along the looms, from which a greater or less number of transmissions are taken. This shafting is driven direct by steam-engines, communicating motion to it by the means of pulleys and belts, while the shafts in turn drove the machines by belts and pulleys.

Factories set up in this way offered a view of shafting and pulleys and belting mingled in inextricable confusion overhead. Every installation of shafting can be divided into two very distinct parts:

Fig. 1.

1. Transmission shafts that run directly to the machinery.
2. Group of intermediate shafts, which are placed between the motors and the transmissions, properly so called, and which only serve to subdivide the work of the motor, modifying its speed and limiting the amount given to the pulleys, etc. This last group varies with the system of transmissions proposed. The first, on the other hand, is constant; whatever may be the system, it is the driving element. The use of systems of mechanical transmissions involve so many serious inconveniences, among which we may name the interdependence of all of the shafting of the shop, which does not allow one shaft to be stopped without stopping all the rest, that it is necessary to use expensive pieces of mechanism, whose action is not always certain. The solution of the problem becomes still more complicated if the industry to which it belongs is liable to numerous stoppages. Furthermore, the motor is compelled to drive a certain amount of dead weight, whereby it is necessary to overcome the inertia of the moving parts and friction resulting from any lack of lubrication. If only a small portion of the factory is in use, the utilization of the driving power is very bad. Another disadvantage lies in the difficulty, and sometimes in the impossibility of extending the plant. If we determine the effective output a system of transmitting relatively to the useful work which is performed and the work which is put into it, the difference between these two quantities is considered the loss—a loss which is inherent in every system of transmission. When power is transmitted by shafting, pulleys, gearing, belts, or ropes, the losses result from the friction of the shafting in their bearings, friction of the teeth of the gear-wheels, slipping of the belts, etc. It is generally admitted that these losses are almost the same whatever may be the amount of work transmitted, whether the shafting be driven empty or up to the full value of its possibilities.

In electrical transmission the losses are in two categories: one fixed, the other variable with the load. Fixed losses are, directly speaking, always constant, and are due to the exciting current and to the Foucault currents, to which it is well to add the friction of the shafting; the losses variable with the load are due to the resistance of the armature wiring. According to Joule's law, it is proportional to the resistance of these conductors and to the squares of the intensity of the current. The sum of these losses includes the energy absorbed in the machine, but all which it absorbs above this is integrally transformed. But when we consider the loss in the line of conductors which connect the dynamo with the motor, we are in possession of all the elements for calculating the efficiency for all transmissions under different loads. If we make this calculation of efficiency for a given system of transmission, first by mechanical processes and then by electrical, we will obtain very different results as the load diminishes. With one-fifth of the power developed, the electrical transmission has an efficiency of more than 40 per cent., while the efficiency of the other falls to nothing.

The question of the efficiency of loads less than the normal is a very important one, for experience teaches that a shop is rarely working under a full load—that is to say, it very rarely happens that all of the machines are working together, there are always a great number of stoppages, either for the workman to adjust his material, set up his machine, or for some other reason. In times of less activity, the number of idle machines increases still more. The power which is utilized grows gradually less in comparison to the great amount of energy absorbed by the system of transmission, and the consumption of coal is entirely out of proportion to the amount of useful work done. As a general thing, accurate ideas relative to the average amount of work absorbed in a shop are not very extensive. It is not infrequently the case that owners are in absolute ignorance in this regard. From a series of tests which have been undertaken, the details of which it is impossible for us to recapitulate here, we may say that the results given, time and again, show that the power required to drive the shafting of an idle shop is greater than that which is absorbed in work during average running. When we consider the small amount of motive power used in useful work at the machine, it is evident that time would be well spent in searching for some improvement in the method of transmis-

sion. In the particular case which we have in hand, besides the question of efficiency the following advantages, which are due to the electrical system of transmission of energy, occupy a prominent place :

1. Facility in arranging the machinery in the most convenient positions, and relatively to light and space. Absolute independence of each machine or room, and the possibility of regulating the speed at will.

2. Convenience in the fitting of the motors, by attaching them directly to the driving-shaft; inspection, starting, stopping, reduced to the narrowest limits.

3. Almost complete suppression of shafting and belts that are so cumbersome and expensive, besides serving as a constant menace to the safety of the operatives. The elimination of dust, and the blowing of it about in the air, due to the constant movements of the belts.

4. Another capital consideration in the mining regions of Saint-Étienne is that such movements of the earth are caused as throw shafting out of line, and result in a considerable increase of power consumed. If the relative position of all parts of a shop were rigidly fixed, this disadvantage would be done away with.

5. Finally, electric light having been decided upon, they considered the advisability of using the light dynamos for driving the motors, the expense of whose installation would not be very much in excess of what a system of shafting would amount to when used for operating shops at some distance from the source of power.

Messrs. Forrest & Co., after having carefully investigated all the advantages which the adoption of electricity seemed to show, decided to install such a system.

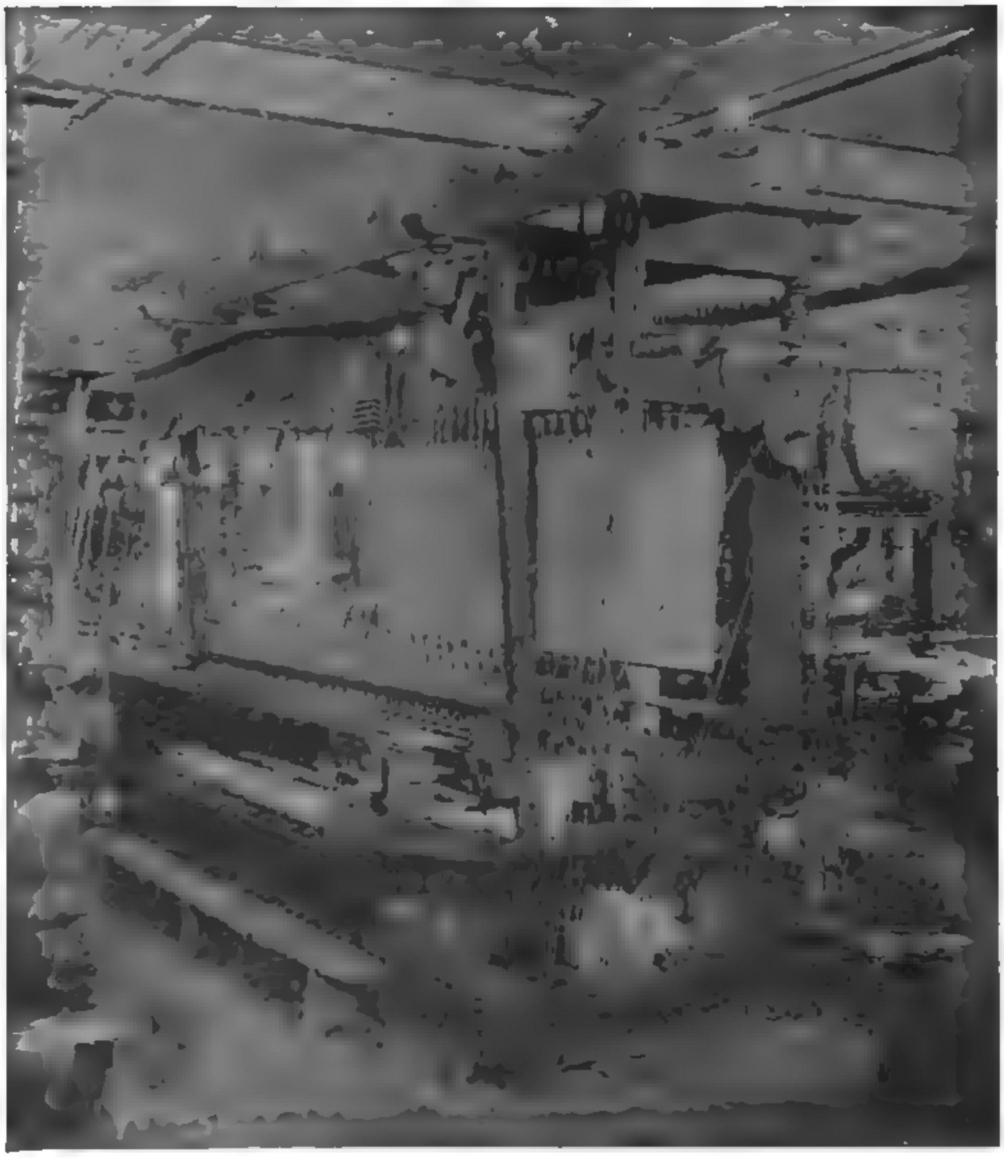


Fig. 2.

The electrical installation includes two tubular boilers which furnish steam, not only to the engine, but also to the general system of heating the shops, offices and storehouses. The steam-engine is a single-cylinder, horizontal, condensing engine with a variable cut-off, controlled by the governor, and developing about 120 H.P. The steam valve is driven by an eccentric rod, and the point of the attachment of the rod to the cut-off valve is movable on a hook, and can be set by hand or by the action of the governor. This engine drives the dynamos directly by means of a belt ; these latter are located symmetrically, relative to the driving pulley. The two dynamos used are of the Sautter-Harlé type, having a capacity of 42,000 watts at 70 volts, while making 600 revolutions per minute. A single pulley set between double bearings drives them by means of a Raffard clutch. These two dynamos are wired, so that they may be used either for motive power or for lighting. Either one can be cut out by means of clutches. A large switchboard, about 13 ft. square, contains the usual supply of electrical measuring instruments and switches. Four sets of insulated cables run out from the dynamos, having a section of ½ sq. in. They pass underground into insulated passages, and come out on each side of the switchboard, and are connected with four large special bars, with the interposition of a bipolar cut-out, and from that point the two negative cables are connected together and are divided into six cables of proper size to serve as return conductors for different services of power and light, being run along the left side of the shop. The positive conductors at each dynamo unite in two circular concentric blocks of bronze; 14 small intermediate blocks are put in connection with them by means of binding screws, with a positive side of one or the other of the dynamos. The blocks are the starting-points for 14 lines of independent circuits which traverse the switchboard. All of these lines run along the right side of the shop. Such an arrangement does away entirely with all risks of short circuits between cables, which for the greater portion of their course are of naked copper attached to porcelain insulators, which facilitate the attachment of the circuits. The branches are made at right angles. All the ramifications are made by means of carefully insulated conductors. Two voltmeters and ampèremeters are in constant service on the switchboard. The regulation is controlled by the two rheostats mounted on marble, as are all the commutators, interrupters, and cut-outs.

A battery of 36 elements of Tudor accumulators, with a capacity of 200 ampère hours, feeds the lamps in the office and storehouse, when the engines are stopped ; 50 arc lamps of 6 ampères each light the storehouse, the vestibule, the work-rooms, and the machine shops ; about 350 incandescent lamps are used for lighting the offices and shop, where each machine

is provided with two lamps. After repeated experiments, electric motors of the Olivet-Dessauls system were adopted. The management have shown that they have an efficiency of not less than 55 per cent. for the 25 kilogrammeter (180 foot-pounds) machines. The speeds do not vary more than 10 per cent., which is a comparatively insignificant matter. Forty 75 kilogrammeter motors located in the weaving-room drive the looms by means of pulleys, as shown in fig. 1. The loose pulley, which permits the motor to continue running when the looms stop, consumes only one-fourth of the current which is absorbed by the full load. In a word, they require an output of from 5 to 10 ampères while running at a normal speed of from 800 to 900 revolutions per minute; when running blank they make 1,000 turns, consuming 2¼ ampères, the current being only cut out for long stoppages. Sixty motors of the 25 kilogrammeter type are placed at the foot of the ribbon and velvet looms, as shown in fig. 2, and drive them by means of leather cords running on a double intermediate pulley fixed on one side above the motor; thence the power is directly transmitted to the loom itself. These motors consume, according to the load, from 2¼ to 5 ampères, and their speed varies from 1,400 to 1,500 revolutions per minute.

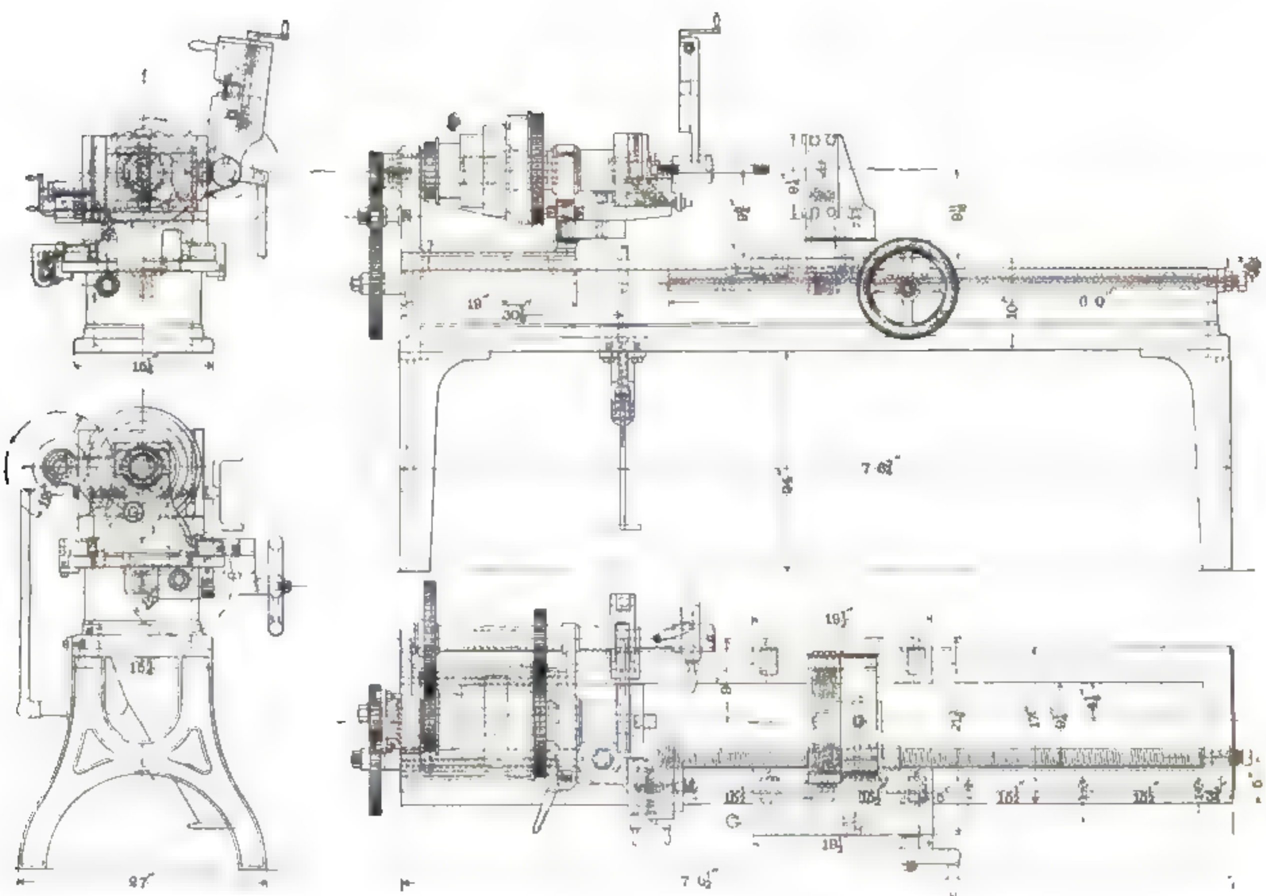
Five motors, with a H.P. of from 1 to 3, control by means of light methods of transmission, the weaving-rooms, mechanical warping, cutting and glossing, the silk throwing and the spindles. Two very small motors of from 10 to 25 kilogrammeter capacity operate the printing-presses and cut off the lengths rolled upon the spools.

This is perhaps the most extensive application of individual driving of weaving machines for high-class fabrics that there is in the world, and it marks an interesting advance in the application of electricity as a motive power from a purely mechanical standpoint. The facts which the author has brought out, and saving in power when only a small portion of the machinery is in active operation, deserves the careful attention of all proprietors who contemplate erection of new shops, whether it is for metal working or for the manufacture of cloth. Freedom from dust due to the absence of pulleys and belting, which act like fans upon the whole surrounding atmosphere, is a matter of the utmost importance to the manufacturers of fine dress goods.

STAY-BOLT CUTTER IN THE PHILADELPHIA & READING RAILROAD SHOPS.

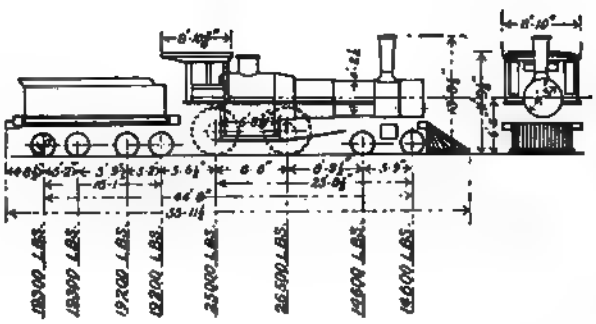
We have from time to time illustrated and described a number of tools that are in use in the shops of the Philadelphia & Reading Railroad, at Reading, Pa. Among the tools that have been designed and built upon the premises is the stay-bolt cutter that is illustrated by the accompanying engravings. The stay-bolts that are used in the boilers of this road have a hexagon head on the under side of the crown-sheet, are screwed through the sheets from the inside, and are kept tight by a copper washer under the head on the inside and by riveting over the projection of the bolt on the outside where it comes through the sheet. It is, therefore, necessary that the thread on the bolt should be cut clear up to the under side of the head, and that the latter should be faced off for a smooth and even bearing on the head. Then, to avoid the loss of time and the wearing of the threads incident to the screwing of a long bolt through the sheet, the thread is cut away between the working points, as shown on the bolt that is in position on the machine. The thread is cut for the whole length of the bolt, and the die is followed by a tool that removes the thread.

In general appearance this machine resembles a light lathe rather than the usual type of bolt cutter. The thread on the bolt is cut by open dies on the carriage, and in order to take the strain off from the thread and dies while the work is being done, the carriage is fed by a lead screw driven by the gearing shown at the end of the headstock. The tool for removing the threads is back of the dies, and is fed in against a stop, so that it just faces off down to the bottom of the threads. Attached to the headstock is a carriage with a cross-feed that

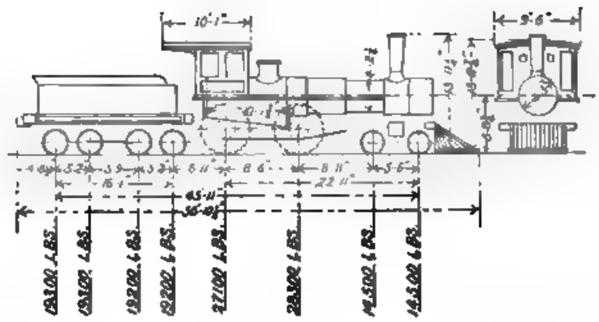


STAY-BOLT CUTTER IN THE PHILADELPHIA & READING RAILROAD SHOPS.

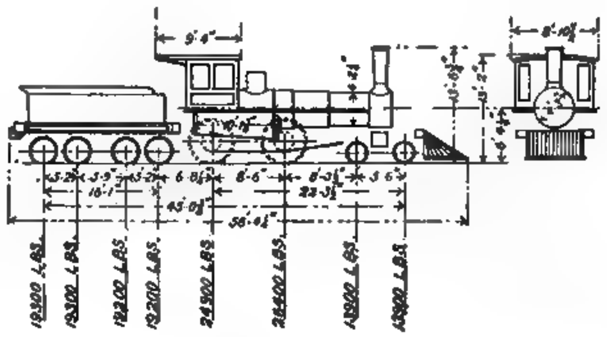
CLASS. A.
(51 to 70)



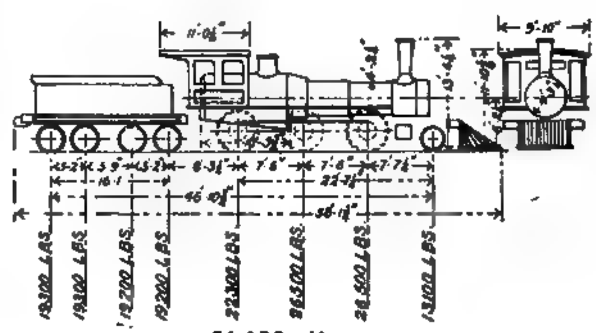
CLASS. A.
(60 ETC)



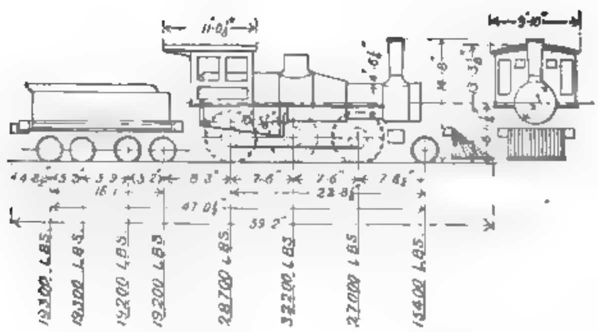
CLASS. B.



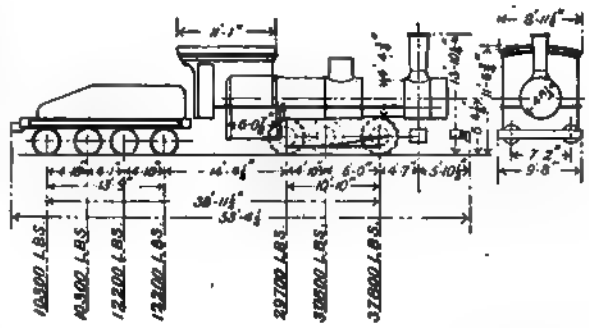
CLASS D.



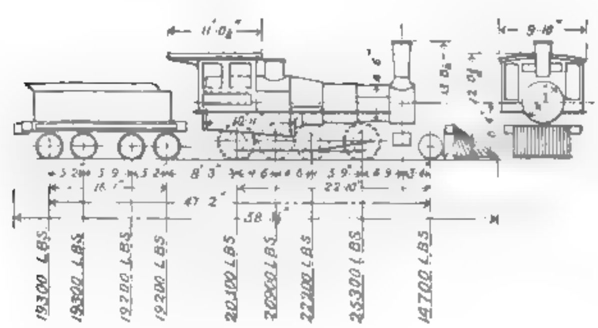
CLASS. E



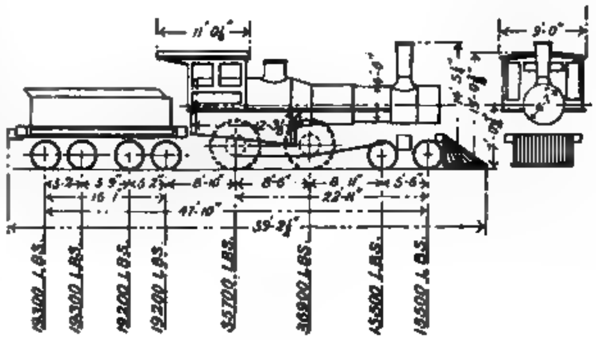
CLASS. H.



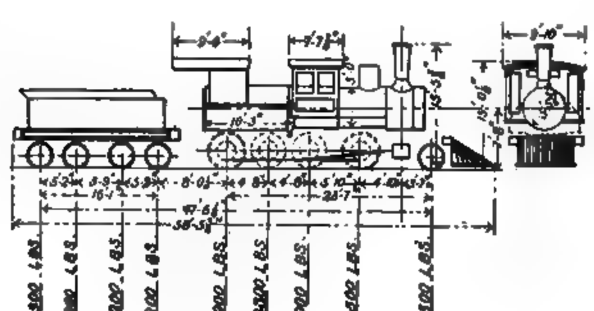
CLASS.



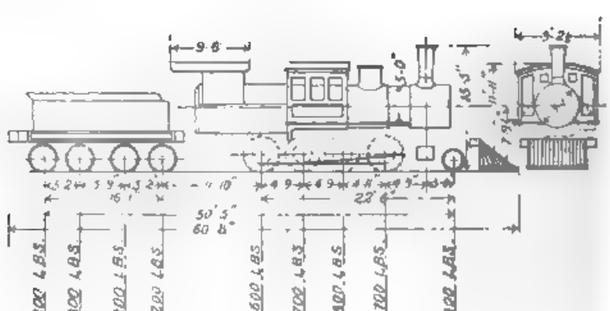
CLASS. K.



CLASS. L.
(698 to 722)

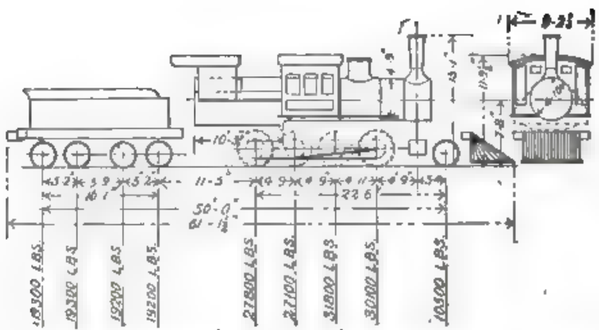


CLASS. L.
(723 to 747)

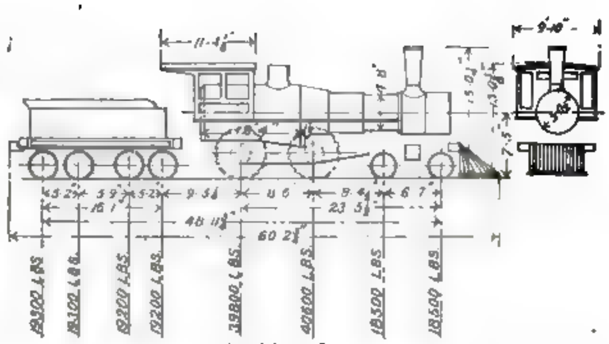


OUTLINES OF STANDARD LOCOMOTIVES ON THE NEW YORK, LAKE ERIE & WESTERN RAILROAD.

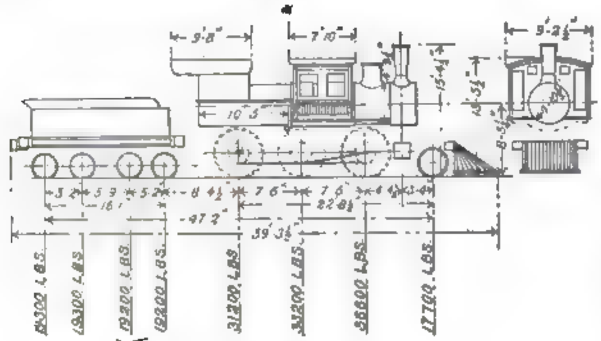
CLASS. L.
(690 to 697)



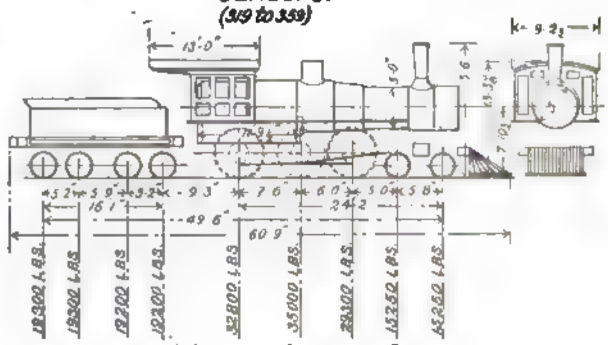
CLASS. M.



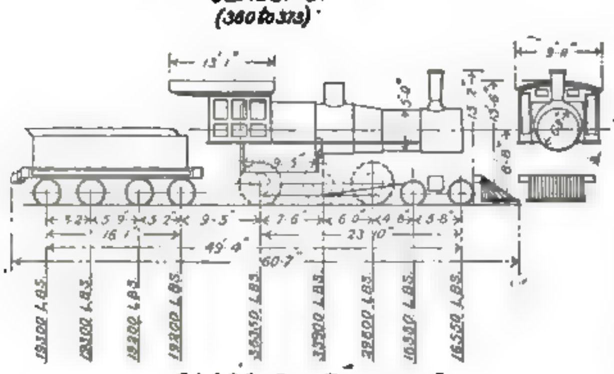
CLASS. N.



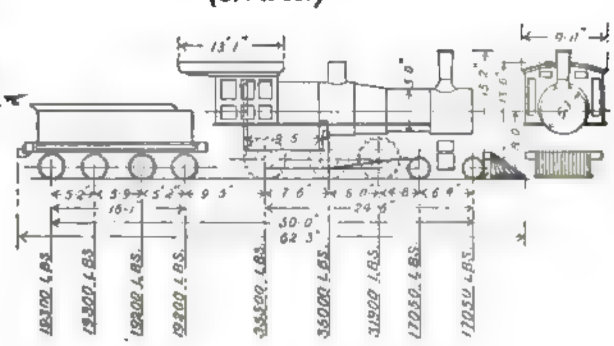
CLASS. O.
(319 to 359)



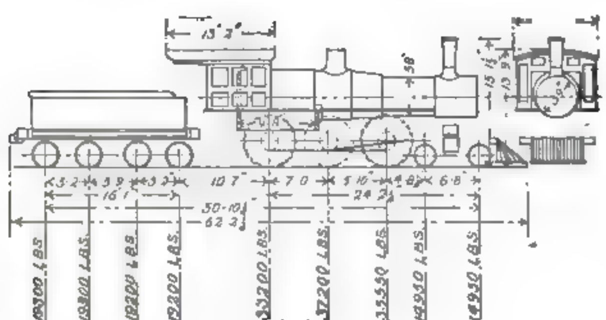
CLASS. O.
(360 to 373)



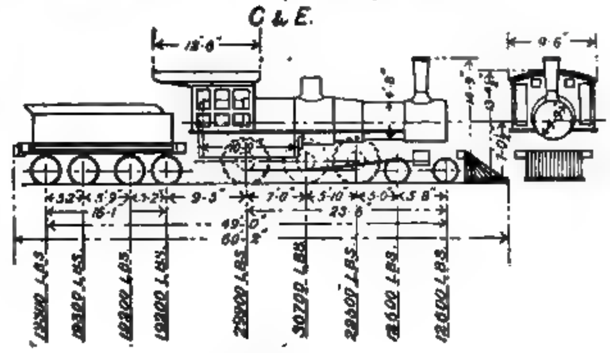
CLASS. O. Compound
(374 to 381)



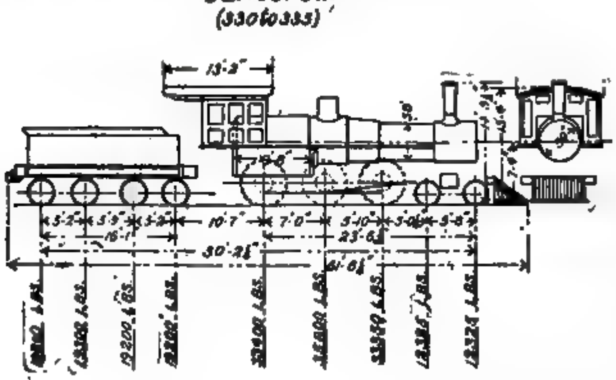
CLASS. Oa. Compound



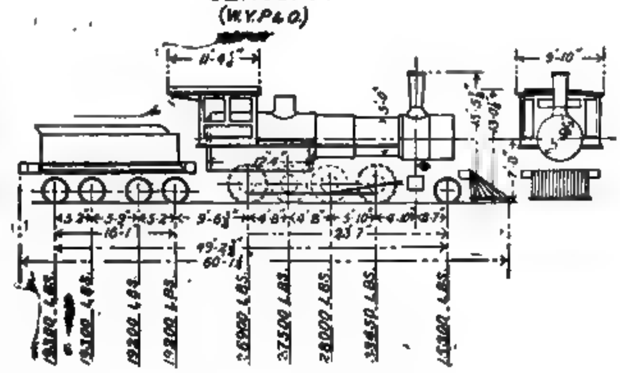
CLASS. Oa. (310 to 329)
C & E.



CLASS. Oa.
(330 to 333)



CLASS. P.
(W.Y.P.& O.)



OUTLINES OF STANDARD LOCOMOTIVES OF THE NEW YORK, LAKE ERIE & WESTERN RAILROAD.

feeds the tool out for facing the bottom of the head. This carriage is pivoted on a stud just outside of the spindle bearing, so that it may be swung out of the way until it is wanted to do its work. At the back of the frame a chaser is hung, and this is used to finish the thread close up to the head. In order that it may work with perfect ease and not endanger the integrity of the threads, the connection between it and the supporting bar is so loose that the latter becomes a mere support and entirely loses its character as a guide, as we find it in the usual practice. The play between the bar and the chaser is 1/4 in., or even more; it matters little what it is, so that it is enough, and the two cannot separate.

The machine is back-geared, and this, together with the four-step driving cone, gives a variation of speeds sufficient to cover the wide range of work which it is called upon to perform. Two of these machines are in constant service in the shops, and are giving excellent satisfaction in the rapid and accurate work done upon them.

THE LOCOMOTIVES OF THE NEW YORK, LAKE ERIE & WESTERN RAILROAD.

The outline diagrams which we publish in this connection represent the several classes of locomotives that are used for the various services on the New York, Lake Erie & Western system, including the Chicago & Erie and the New York, Pennsylvania & Ohio Railroads.

CLASS A.

Designed for local passenger service of short trains.

DIMENSIONS OF 51 TO 70.

Diameter of cylinders	18 in.
Stroke of piston	22 in.
Diameter of drivers	5 ft. 8 in.
No. of flues	168
Length of flues	11 ft. 6 in.
Outside diameter of flues	2 in.
Heating surface, flues	1,008 sq. ft.
" " fire-box	106 sq. ft.
Total heating surface	1,109 ft.
Inside length of fire-box	6 ft. 3/16 in.
" width " "	2 ft. 9 3/8 in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	80,200 lbs.

DIMENSIONS OF 80, ETC.

Diameter of cylinders	18 in.
Stroke of piston	22 in.
Diameter of drivers	5 ft. 8 in.
No. of flues	157
Length of flues	11 ft. 5 13/16 in.
Outside diameter of flues	2 in.
Heating surface flues	938.5 sq. ft.
" " fire-box	114.5 sq. ft.
Total heating surface	1,053 sq. ft.
Inside length of fire-box	9 ft. 5 1/4 in.
" width " "	2 ft. 9 1/2 in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	84,700 lbs.

CLASS B.

Used on local passenger and light freight.

DIMENSIONS.

Diameter of cylinders	18 in.
Stroke of piston	22 in.
Diameter of drivers	5 ft. 2 in.
No. of flues	157
Length of flues	11 ft. 6 in.
Outside diameter of flues	2 in.
Heating surface, flues	938.5 sq. ft.
" " fire-box	114.5 sq. ft.
Total heating surface	1,053 sq. ft.
Inside length of fire-box	9 ft. 5 1/4 in.
" width " "	2 ft. 9 1/2 in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	79,100 lbs.

CLASS D.

For local freight traffic.

DIMENSIONS.

Diameter of cylinders	18 in.
Stroke of piston	24 in.
Diameter of drivers	4 ft. 8 in.
No. of flues	168
Outside diameter of flues	2 in.
Heating surface, flues	1,029 sq. ft.
" " fire-box	120 sq. ft.
Total heating surface	1,149 sq. ft.
Length of flues	11 ft. 8 1/8 in.
Inside length of fire-box	9 ft. 9 3/16 in.
" width " "	2 ft. 9 3/8 in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
Weight of engine, loaded	88,400 lbs.

CLASS E.

Mogul for heavy passenger trains carrying commuters and for milk service.

DIMENSIONS.

Diameter of cylinders	18 in.
Stroke of piston	24 in.
Diameter of drivers	5 ft. 8 in.
No. of flues	218
Length of flues	11 ft. 8 1/8 in.
Outside diameter of flues	2 in.
Heating surface, flues	1,296.5 sq. ft.
" " fire-box	152.5 sq. ft.
Total heating surface	1,449 sq. ft.
Inside length of fire-box	9 ft. 8 13/16 in.
" width " "	2 ft. 9 1/8 in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	108,300 lbs.

CLASS H.

General switching service, both passenger and freight.

DIMENSIONS.

Diameter of cylinders	19 in.
Stroke of piston	24 in.
Diameter of drivers	4 ft. 2 in.
No. of flues	122
Length of flues	14 ft. 9 1/8 in.
Outside of flues	2 1/2 in.
Heating surface, flues	1,174 sq. ft.
Inside length of fire-box	5 ft. 3 3/16 in.
" width " "	2 ft. 10 1/8 in.
Heating surface, fire-box	100 sq. ft.
Total heating surface	1,274 sq. ft.
Capacity of tender, water	2,400 galls.
" " " coal	3 tons.
Weight of tender, empty	20,000 lbs.
" " engine, loaded	98,100 lbs.

CLASS I.

Originally designed for through freight, but is now used on heavy local freight and pick-ups, while some of the class are in switching service.

DIMENSIONS.

Diameter of cylinders	20 in.
Stroke of piston	24 in.
Diameter of drivers	4 ft. 2 in.
No. of flues	200
Length of flues	11 ft. 4 1/8 in.
Outside diameter of flues	2 in.
Heating surface, flues	1,182.5 sq. ft.
" " fire-box	140.5 sq. ft.
Total heating surface	1,323 sq. ft.
Inside length of fire-box	10 ft. 2 3/16 in.
" width " "	2 ft. 9 in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	108,400 lbs.

CLASS K.

Heavy commuters, trains, through local expresses, such as are run on the Northern Railroad of New Jersey; also used for division work in express service.

DIMENSIONS.

Diameter of cylinders	18 in.
Stroke of piston	22 in.
Diameter of drivers	5 ft. 8 in.
No. of flues	225
Length of flues	11 ft. 6 in.
Outside diameter of flues	2 in.
Heating surface, flues	1,345 sq. ft.
" " fire-box	158 sq. ft.
Total heating surface	1,503 sq. ft.
Inside length of fire-box	11 ft. 6 3/16 in.
" width " "	2 ft. 8 3/8 in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	108,600 lbs.

CLASS L.

A Wootten consolidation for freight service.

DIMENSIONS 698 TO 722.

Diameter of cylinder	20 in.
Stroke of piston	24 in.
Diameter of drivers	4 ft. 2 in.
No. of flues	235
Length of flues	11 ft. 10¾ in.
Outside diameter of flues	2 in.
Heating surface, flues	1,584 sq. ft.
" " fire-box	174 sq. ft.
Total heating surface	1,758 sq. ft.
Inside length of fire-box	9 ft. 6$\frac{3}{16}$ in.
" width of fire-box	8 ft.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of " empty	32,800 lbs.
" " engine, loaded	130 200 lbs.

DIMENSIONS 723 TO 747.

Diameter of cylinder	20 in.
Stroke of piston	24 in.
Diameter of drivers	4 ft. 2 in.
No. of flues	206
Length of flues	11 ft. 2¼ in.
Outside diameter of flues	2 in.
Heating surface, flues	1,206.5 sq. ft.
" " fire-box	161.5 sq. ft.
Total heating surface (including combustion chamber)	1,416.5 sq. ft.
Inside length of fire-box	9 ft. 6 in.
" width " "	8 ft. 2½ in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	131,600 lbs.

DIMENSIONS 690 TO 697.

Diameter of cylinder	20 in.
Stroke of piston	24 in.
Diameter of drivers	4 ft. 2 in.
No. of flues	204
Length of flues	11 ft. 2¼ in.
Outside diameter of flues	2 in.
Heating surface, flues	1,195 sq. ft.
" " fire-box	160 sq. ft.
Total heating surface (including combustion chamber)	1,408.5 sq. ft.
Inside length of fire-box	9 ft. 6 in.
" width " "	8 ft. ⅛ in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	127,800 lbs.

CLASS M.

For heavy commuters' trains and through passenger service.

DIMENSIONS.

Diameter of cylinder	19 in.
Stroke of piston	24 in.
Diameter of drivers	5 ft. 8 in.
No. of flues	246
Length of flues	11 ft. 6 in.
Outside diameter of flues	2 in.
Heating surface, flues	1,470.5 sq. ft.
" " fire-box	160.5 sq. ft.
Total heating surface	1,631 sq. ft.
Inside length of fire-box	11 ft. 6$\frac{3}{16}$ in.
" width " "	3 ft. 5⅝ in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	117,400 lbs.

CLASS N.

Through passenger traffic.

DIMENSIONS.

Diameter of cylinder	20 in.
Stroke of piston	24 in.
Diameter of drivers	5 ft. 8 in.
No. of flues	336
Length of flues	9 ft. 5⅜ in.
Outside diameter of flues	1½ in.
Heating surface, flues	1,241 sq. ft.
" " fire-box	181 sq. ft.
Total heating surface (including combustion chamber)	1,458.5 sq. ft.
Inside length of fire-box	9 ft. 6 in.
" width " "	8 ft. ¼ in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	118,700 lbs.

CLASS O.

Through freight and passenger on light and level divisions.

DIMENSIONS 819 TO 359.

Diameter of cylinders	20 in.
Stroke of piston	24 in.
Diameter of drivers	5 ft. 8 in.
No. of flues	275
Length of flues	13 ft. 2 in.
Outside diameter of flues	2 in.
Heating surface, flues	1,895.9 sq. ft.
" " fire-box	171 sq. ft.
Total heating surface	2,066.9 sq. ft.
Inside length of fire-box	11 ft. $\frac{7}{16}$ in.
" width " "	3 ft. 7 in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	127,600 lbs.

DIMENSIONS 360 TO 370.

Diameter of cylinder	20 in.
Stroke of piston	24 in.
Diameter of drivers	62 in.
No. of flues	263
Length of flues	13 ft. 2 in.
Outside diameter of flues	2 in.
Heating surface, flues	1,813 sq. ft.
" " fire-box	177 sq. ft.
Total heating surface	1,990 sq. ft.
Inside length of fire-box	8 ft. 8 in.
" width " "	42⅝ in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	132,950 lbs.

CLASS O (COMPOUND).

Same service as the simple engines.

DIMENSIONS.

Diameter of cylinder	14 and 24 ins
Stroke of piston	24 in.
Diameter of drivers	62 in.
No. of flues	263
Length of flues	13 ft. 2 in.
Outside diameter of flues	2 in.
Heating surface, flues	1,813 sq. ft.
" " fire-box	177 sq. ft.
Total heating surface	1,990 sq. ft.
Inside length of fire-box	8 ft. 8 in.
" width " "	42⅝ in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	136,500 lbs.

CLASS O *a* (COMPOUND).

Through passenger and freight service on the Chicago & Erie Railroad.

DIMENSIONS.

Diameter of cylinder	14½ in. and 25 in.
Stroke of piston	24 in.
Diameter of drivers	68 in.
No. of flues	218
Length of flues	13 ft. 6 in.
Outside diameter of flues	2 in.
Heating surface, flues	1,505.6 sq. ft.
" " fire-box	156.3 sq. ft.
Total heating surface	1,661.9 sq. ft.
Inside length of fire-box	9 ft.
" width " "	32 in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	135,850 lbs.

CLASS O *a*.

Same service on Chicago & Erie Railroad.

DIMENSIONS.

Diameter of cylinders	19 in.
Stroke of piston	24 in.
Diameter of drivers	5 ft. 2 in.
No. of flues	195
Length of flues	13 ft. 6 in.
Outside diameter of flues	2 in.
Heating surface, flues	1,378.37 sq. ft.
" " fire-box	166.88 sq. ft.
Total heating surface	1,545.25 sq. ft.
Inside length of fire-box	10 ft.
" width " "	2 ft. 9⅜ in
Capacity of tender, water	3,600 galls
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	115,300 lbs.

DIMENSIONS 330 TO 335.

Diameter of cylinders	19 in.
Stroke of piston	24 in.
Diameter of drivers	62 in.
No. of flues	218
Length of flues	13 ft. 6 in.
Outside diameter of flues	2 in.
Heating surface, flues	1,505.6 sq. ft.
" " fire-box	156.3 sq. ft.
Total heating surface	1,661.9 sq. ft.
Inside length of fire-box	9 ft.
" width " "	33 in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	127,200 lbs.

CLASS P.

Through freight service on the New York, Pennsylvania & Ohio Railroad.

DIMENSIONS.

Diameter of cylinders	20 in.
Stroke of piston	24 in.
Diameter of drivers	4 ft. 2 in.
No. of flues	289
Length of flues	11 ft. 5⅝ in.
Outside diameter of flues	2 in.
Heating surface, flues	1,424.75 sq. ft.
" " fire-box	188.75 sq. ft.
Total heating surface	1,613.5 sq. ft.
Inside length of fire-box	11 ft. 6⅛ in.
" width " "	3 ft. 5⅜ in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	131,150 lbs.

CLASS Q.

Through passenger service on the New York, Pennsylvania & Ohio Railroad.

DIMENSIONS.

Diameter of cylinders	18 in.
Stroke of piston	24 in.
Diameter of drivers	5 ft. 8 in.
No. of flues	221
Length of flues	12 ft. 6 in.
Outside diameter of flues	2 in.
Heating surface, flues	1,321 sq. ft.
" " fire-box	133 sq. ft.
Total heating surface	1,458 sq. ft.
Inside length of fire-box	5 ft. 11 1/16 in.
" width " "	2 ft. 10¼ in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,600 lbs.
" " engine, loaded	106,600 lbs.

CLASS R.

Fast freight.

DIMENSIONS.

Diameter of cylinders	21 in.
Stroke of piston	26 in.
Diameter of drivers	5 ft. 2 in.
No. of flues	258
Length of flues	10 ft. 10 in.
Outside diameter of flues	2 in.
Heating surface, flues	1,480 sq. ft.
" " fire-box	156.5 sq. ft.
Total heating surface (including combustion chamber)	1,699 sq. ft.
Inside length of fire-box	9 ft. 5 11/16 in.
" width " "	8 ft. 2½ in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	138,100 lbs.

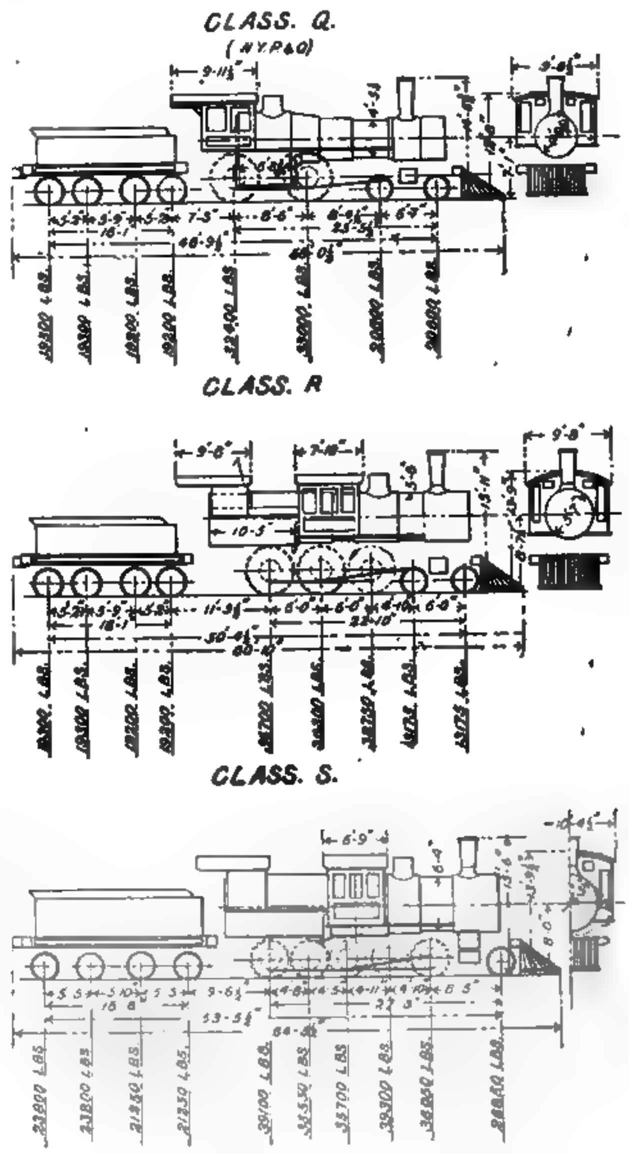
CLASS S (COMPOUND).

Heavy pushers.

DIMENSIONS.

Diameter of cylinders	16 & 27 in.
Stroke of pistons	28 in.
Diameter of drivers	4 ft. 2 in.
No. of flues	354
Length of flues	12 ft. ¼ in.
Outside diameter of flues	2 in.
Heating surface, flues	2,213 sq. ft.
" " fire-box	179 sq. ft.
" " combustion chamber	48.5 sq. ft.
Total heating surface	2,440.5 sq. ft.
Inside length of fire-box	10 ft. 11¼ in.
" width " "	8 ft. 2½ in.
Capacity of tender, water	4,500 galls.
" " " coal	10 tons.
Weight of tender, empty	
" " engine, loaded	200,550 lbs.

An interesting feature of this classification of locomotives is the absence of all cylinders of less than 18 in. in diameter. Even for the light passenger traffic, where probably not more than four or five cars are hauled in a train, the cylinder diameters are kept up to these dimensions. A man need not be so very old to remember when 16 in. was the standard diameter for the large engines on through trunk lines handling a heavy traffic. With cylinder diameters increased the heating surface has also arisen, though perhaps not in the same proportions. Class A, for example, with 18-in. cylinders, has a total heating surface of only 1,109 sq. ft., while even more than this has frequently been given for 16-in. cylinders doing the same class of work, while the second division of Class A and Class B have only 1,058 sq. ft. But when we consider the heating surface of 2,066.9 sq. ft., that is obtained on Class O, it is amusing to remember the struggles with the 16-in. engines, when attempts were being made to raise the heating surface to 1,300 sq. ft. Equally significant is the tremendous weight that is now put upon drivers. The 40,600 lbs. that is put upon the forward pair of drivers of Class M would have been considered impossible but a few years ago. It is such work as this that causes the triangular contest between the operating, road and motive power departments. The Operating Department calls upon the Superintendent of Motive Power to haul heavier trains; the latter tells the chief engineer to strengthen his bridges, and the engineer protests that he must have more metal if he is to do it. The opinion seems to prevail in some quarters, however, that the limit is nearly reached, as trains are about as long as it is safe to haul.



STANDARD LOCOMOTIVE OUTLINES N. Y., L. E. & W. R. R.

PROCEEDINGS OF SOCIETIES.

New York Railroad Club.—The regular monthly meeting was held on the evening of November 16, at which time the annual election took place, resulting in the election of George W. West, Superintendent of Motive Power of the New York, Ontario & Western Railway, as President; of A. E. Mitchell, Superintendent of Motive Power of the New York, Lake Erie & Western Railroad, as First Vice-President, and W. H. Lewis, Master Mechanic of the Delaware, Lackawanna & Western Railroad, as Second Vice-President. At the October meeting the position of Secretary was made an appointive office under the direction of the executive committee. Previous to the election of officers, Mr. R. H. Parks read an exceedingly interesting paper on the use of compressed air for shop purposes.

American Railway Master Mechanics' Association.—The joint circulars of the Master Mechanics' and the Master Car-Builders' Associations have been issued by their respective secretaries, and announce that the Master Car-Builders and the Master Mechanics have decided on the Thousand Islands, at Alexandria Bay, for the place of their next meeting in June, 1895. The committee have made the following arrangements with Mr. J. B. Wister, proprietor of the Thousand Island House, Thousand Islands, Alexandria Bay, N. Y., and Mr. Charles W. Crossmon, proprietor of the Crossmon House, Thousand Islands, Alexandria Bay, N. Y., as to terms, as follows: Single rooms, with board, $3 per day each person; single rooms, with board and bath, $4 per day each person; double rooms, with two persons, $3 per day each person. These rates are to members of the Association and their friends. Applications for rooms should be made to Mr. J. B. Wister, proprietor of the Thousand Island House, Thousand Islands, Alexandria Bay, N. Y., and Mr. Charles W. Crossmon, proprietor of the Crossmon House, Thousand Islands, Alexandria Bay, N. Y. The committee request that members will apply at once for rooms, as those who first apply will be best served.

Engineers' Club of St. Louis.—At a meeting held November 7, Professor H. A. Wheeler read a paper on The Merz Process of Handling Garbage at the South St. Louis Works.

Previous to 1891 the garbage had been dumped in the river, the quantity then being estimated at 40 tons per day. It now averages 150 tons daily, and has reached 300 on Mondays during the watermelon season, the daily quantity per capita varying between ½ and 1 lb. All garbage is now reduced by the St. Louis Sanitary Company, the city paying them 9 cents per pound up to 200 tons daily, above which quantity it is reduced free of charge. The upper, or No. 1 plant, built 4 years ago, was originally of 40 tons capacity; it was later increased to 75 tons, and last summer handled as high as 100 tons. The No. 2 plant, at the foot of Chouteau Avenue, was only temporary, and has been abandoned. The No. 3 plant is located at the foot of Montana Street, in South St. Louis, and began operations in the spring of 1894. Its daily capacity is 200 tons. Professor Wheeler explained in detail the system employed, devoting special attention to the methods of ventilation. In his opinion the plant was of great interest to engineers, and deserved the good opinion of the profession as representing an intelligent effort in the direction of a solution of a most difficult problem.

American National Association of Railway Superintendents of Bridges and Buildings.—The fourth annual meeting was held at Kansas City, Mo., October 16–19. The subjects upon which reports were received and discussed were: Depressed Cinder Pits; the Best Method of Bridge Inspection; Maintenance of Pile and Frame Trestles; and the Best Scale Foundation. The next meeting is to be held on the third Tuesday of October, 1895, at Atlanta, Ga., where the subjects of papers to be read and discussed will be as follows: Mechanical Action and Resultant Effects of Motive Power at High Speed on Bridges; Methods and Special Appliances for Building Temporary Trestles over Wash-outs and Burn-outs; Strength of Various Kinds of Timber used in Trestles and Bridges, Especially with Reference to Southern Yellow Pine, White Pine, Fir and Oak; Best Method of Erecting Plate Girder Bridges; Best and Most Economical Railway Track Pile Driver; Sand Dryers, Elevators and Methods of Supplying Sand to Engines, Including Buildings; Span Limits for Different Classes of Iron Bridges and Comparative Merits of Plate Girder and Lattice Bridges for Spans from 50 ft. to 110 ft.; Best Method of Spanning Openings too Large for Box Culverts, and in Embankments too Low for Arch Culverts; Best End Construction for Trestles Adjoining Embankments; Interlocking Signals; Pumps and Boilers.

Society of Naval Architects and Marine Engineers.—The annual meeting was held at the house of the American Society of Mechanical Engineers on Thursday and Friday, November 15 and 16. In another column we reprint the main portion of the paper by Commodore George W. Melville, and regret that lack of space prevents a more elaborate review of the proceedings. The following is a list of the papers that were read: Some Suggestions of Professional Experience in Connection with the Naval Construction of the last Ten Years—1884–1894, by Richard W. Meade, Rear-Admiral, U. S. Navy; The Use of Small Models for the Determination of Curves of Stability, by E. Bertin, Director of the French Government School of Naval Design; Some Obstacles to Ship-Building and Owning in this Country, by George W. Dickie, Esq., Naval Architect, San Francisco, Cal.; Present Status of Face-Hardened Armor, by W. T. Sampson, Captain and Chief of Ordnance, U. S. Navy; Cellulose and its Application to Warships, by E. Cheneau, Philadelphia, Pa.; Experience Gained with our New Steel Ships as Regards Care and Preservation, by Philip Hichborn, Chief Constructor, U. S. Navy; The U. S. Triple-screw Cruisers *Columbia* and *Minneapolis*, by George W. Melville, Engineer-in-Chief, U. S. Navy; Electricity on Shipboard: its Present Position and Future Development, by S. Dana Greene, Esq., New York, N. Y.; Hydraulic Power for Warships, by Albert W. Stahl, Naval Constructor, U. S. Navy; Yachts in England and America, by Lewis Nixon, Esq., Naval Architect, Philadelphia, Pa.; A Dynamic Steam Engine Indicator Tester, by Professor Cecil H. Peabody and Assistant Professor E. F. Miller, Massachusetts Institute of Technology; An Approximate Formula for the Wetted Surface of Ships, by W. F. Durant and G. R. McDermott; Notes on Launching, by William J. Baxter, Naval Constructor, U. S. Navy; Accessibility and Circulation of Water-tube Boilers, by L. D. Davis, Esq., M.E., Erie, Pa.; Recent Light-draft Gunboats of the U. S. Navy, by J. J. Woodward, Naval Constructor, U. S. Navy.

Master Car-Builders' Association.—The Secretary has recently sent out the following circular relative to the standards that have been adopted by the Association:

"Replies to circular dated September 4, in regard to gauges recently adopted by the Association, do not indicate that orders for 50 sets can be assured at the prices quoted by gauge manufacturers. Many of the replies indicate that the prices quoted are considered too high, and that gauges have been or will be made by the companies at their own shops. The Executive Committee has again considered the question, and decided that it cannot effect satisfactory arrangements with gauge manufacturers for these gauges. It recommends that railroad companies making these gauges should have the large lithograph drawings of same from this office, so that the gauges may be properly made in so far as the essential or gauging dimensions are concerned.

"The Executive Committee has examined the 15 sheets of lithograph drawings showing all the standards and recommended practice revised to date—that is, including changes and new matter since the ballot of 1894—and believes that members do not fully appreciate the importance of having a full set of these drawings for reference in following M. C. B. standards as thoroughly as possible. The Secretary has, therefore, been instructed to call attention again to this matter, as coming from the Executive Committee with its recommendation as above.

"When originally issued in 1893 there were sheets 1 to 11, inclusive, of M. C. B. standards, and sheets A and B of recommended practice. By the ballot of 1894 sheets 1, 2, 3, 8 and A were revised, and sheets 12 and C were originally issued, so that we now have sheets 1 to 12, inclusive, of M. C. B. standards, and sheets A, B and C of recommended practice, all as revised and completed to date.

"The new sheets of 1894, Nos. 12 and C, are as follows: Sheet 12 - Standard Terms and Gauging Points for Wheels and Track; Guard Rail and Frog Wing Gauge; Check Gauge for Mounting Wheels; Wheel Tread; Flange Thickness Gauges for New Wheels. Sheets C—Recommended Practice for Journal Bearing and Wedge Gauges; Safety Chains for Freight Cars; Minimum Thickness of Steel Tires; Dummy Coupling Hook. These lithographs are made on thin semi-transparent paper, so that blue prints may be taken therefrom the same as from tracings. They are sold at 25 cents per copy, or $3.75 for a set of 15 sheets."

Universal Exposition at Amsterdam, 1895.—We are in receipt of a circular dated at Amsterdam, announcing that a universal exposition will be held in that city under the patronage of Her Majesty the Queen Regent of the Netherlands, from May 1 to November 1, 1895. It is announced that the Exposition building, with its extensions, will cover 47,800 sq. yds., built of iron and sheathed in durable materials. The length of the main gallery will be 3,900 ft., and the height 46 ft. and the breadth 82 ft. In front of the monumental façade, having the breadth of 737 ft., there will extend 16 hectares (acres) of gardens and lawns for the exhibition of trees and plants. The present address is at 50 Marche St. Jacque, Antwerp, Belgium.

Discussing Aerial Locomotion.—At the meeting of the German Congress of Natural Science held in Vienna in September, Professor Boltomann delivered an interesting lecture on aerial locomotion. He predicted the greatest success for the application of aeroplanes in which the principle of an oblique plane is employed. He referred to Maxim's machine as a second step in advance.

PERSONAL.

Charles A. Sheldon, a graduate of Yale, and until recently Assistant Division Superintendent on the Michigan Division of the Lake Shore Railroad, has resigned that position and made an engagement with the Consolidated Company, and will have charge of the compressed gas-lighting department. That company is about to introduce the Pope system, which will be interchangeable with the Pintsch system.

Manufactures.

BAND RE-SAWING MACHINE.

We illustrate herewith a new band re-sawing machine which has been produced by the manufacturers to fill the wants of cabinet-makers, coach-builders, sash-and door manufacturers and all others where the requirements are for both re-sawing and hand or scroll work.

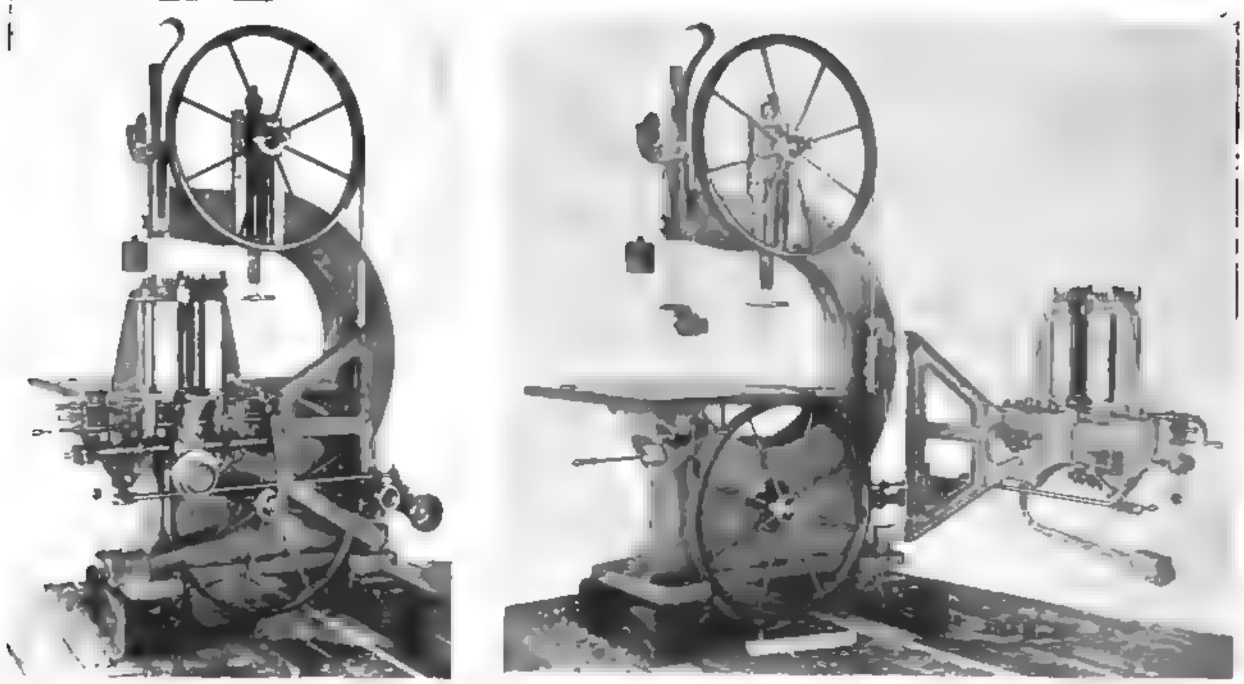


Fig. 1. Fig. 2.

BERRY & ORTON COMPANY'S BAND RE-SAWING MACHINE.

This is a powerful machine, weighing over 4,000 lbs., and is so arranged that in re-sawing, the feed works are swung into their place and fastened by a single nut; there being no belts to take off or parts to disconnect, the operation consumes less than one minute. When the machine is to be used for plain or scroll sawing, the arms carrying the feed works are swung open, as is shown by the illustration, fig. 2.

The feed rollers are strongly geared, and will automatically center the material to be sawn, or they can be set so as to slab from one side of a timber by simply loosening one nut and tightening another. The rollers are set for different thicknesses of material by means of the crank shown at the left, near the table, and will also tip for sawing bevel siding or other work that may be needed. They are started and stopped independently of the machine, or the feed can be instantly stopped by raising the weight lever shown in front. The feed has three changes.

The machine will take lumber 22 in. wide and up to 8 in. thickness, and will carry saws 3¼ in. wide and less down to saws for the finest scroll work. The latest improved roller guides are supplied, the top one being counterweighted to prevent accidents by falling on the work.

These machines are built in five different sizes, weighing from 3,000 lbs. up to 12,000 lbs., carrying saws from 2 in. to 8 in. wide, being the largest line made in the country, filling the requirements of any work that may be needed of them.

For further information concerning the above, address the manufacturers, Berry & Orton Company, Twenty-third and Arch streets, Philadelphia, Pa.

THE FINLAYSON WATER-TUBE BOILER.

The interest centering in the use of water-tube boilers, both for stationary and marine water, which was so plainly evidenced at the meeting of the members of the American Society of Mechanical Engineers last spring, and reported in The American Engineer for June, is evidently not confined to this country. On page 547 of this issue we publish a translation of a very interesting paper on water-tube boilers, which was recently read before a German engineering society, in which a number of various types of water-tube boilers were described and discussed. Among the boilers which have recently been brought to the attention of the public in this country is the Finlayson boiler, manufactured by the Finlayson Boiler Company, Limited, of Detroit, Mich., of which we give two illustrations. The principle of the operation of this boiler is that the circulation of water shall be maintained in vertical directions, and that after the liberation of the steam from the water it shall be thereafter superheated before being used in the engine, while the waste products of combustion are utilized, as far as possible, with the feed water before it is delivered to the boiler itself. In order to utilize all the space surrounding the boiler to as great an extent as possible the front and back heads, instead of being lined up with fire-brick or other non-conducting material, are formed of water legs with flat surfaces and held together by stay-bolts after the manner of the water legs of locomotive boilers. At the bottom and out toward the sides these water legs are attached to each other by a large pipe, which is known as the side-flow pipe. At the top they are connected by the steam drum, to which direct access is obtained by means of the hand-hole plate, shown at the front of the engraving.

This steam drum naturally varies in the size with that of the boiler, but it is intended to be so designed that the steam space shall be ten times the capacity of the engine cylinder. This drum is kept half full of water, and as the outer surfaces of the water legs are naturally cooler than the inner surfaces, the flow of the water takes place from the drum down the outside portion of the water legs into the side flow pipes, and thence up through the circulating pipes, back through the drum. The distance which the water is obliged to traverse through

these smaller vertical pipes, which are used for heating purposes, is quite short, being from 2 ft. to 3 ft., depending on the size of the boiler.

Fig. 1.

BOILER COMPLETE, EXCEPTING SUPERHEATING COILS AND SIDE-CASING, SHOWING SIDE FLOW PIPES, STEAM DRUM, ARRANGEMENT OF STEAM-GENERATING LOOPS AND FEED-WATER COILS.

In order to obtain the superheating to which reference has already been made, the coils are placed on either side of the boiler in such a position that they receive the heat which passes between the side flow pipes. The arrangement of these pipes is also different from anything else which we have thus far seen; instead of having the superheating pipes in one continuous coil, through the whole length of which all of the steam must pass, these are made in short lengths, with manifold connections both at top and bottom. Steam on leaving the drum does so through a perforated dry pipe lying along the upper side, thence comes downward toward the lower connection of these superheating pipes, and is distributed through them, rising again to the main supply pipe to the engine. Thus any water which may pass over through the steam drum into these pipes is not carried on to the engine cylinder, because the area of the upright pipes in the manifold is about fifteen times as much as that of the main steam pipe, so that there is no driving rush of steam through any one of them tending entrain water.

Blow-off pipes are placed at each lower corner of the water legs, through which the boiler can be readily washed out and the sediment, which would naturally collect at these points, be easily removed.

The feed-water coils are placed above the steam-generating section in a horizontal position, as shown in fig. 2, and the feed water is then carried back and through them until the boiling point is reached, when it is delivered into the side flow pipes on either side.

The loops in which the steam is generated are divided length-wise of the boiler, and thus provide for proper expansion and contraction. The steam drum being carried half full of water, all of the pipes and connections which are exposed to the direct action of the fire are protected by water.

A LESSON IN MILLING.

The Pratt & Whitney Company, of Hartford, Conn., have sent us some very interesting photographs showing a "gang mill," for cutting corrugations in the surface of heavy plates and finishing the whole plate at one operation. As these illustrations have already appeared in a number of other technical papers, they are not reproduced. The one represents a view from a washed drawing showing the machine in which the milling was done, and the other is an enlarged view of the "gang mill."

Of the work done by this machine and the tool referred to, this Company say:

"An achievement in the line of surface milling which so far surpasses anything in the ordinary as to make it of special interest, is at present in progress at the works of the Pratt & Whitney Company, Hartford, Conn., and which is illustrated herewith from photographs taken of the machine in operation.

"The work consists in the corrugation of metal plates by milling, using gang mills and finishing a plate at one cut.

"These plates are of steel $\frac{3}{4}$ in. thick, 24 in. wide, and 40 in. long. The corrugations are formed of arcs of circles of $\frac{5}{16}$-in. radius, and cover a surface 20 in. wide by 33 in. long, and milled to a depth of $\frac{3}{16}$ of an inch, requiring, as will be seen, a gang of mills 33 in. in length to do the work.

"Spencer Kellogg, of Buffalo, N. Y., for whom this work is being done, uses in the manufacture of a certain product about 1,000 of these plates, and so great has been the need of them that it has been necessary to work 24 hours per day, using double sets of mills to avoid the loss of time consumed in grinding.

"The manner of making these mills will also be of interest. One set is made up of 30 separate pieces, each 8 in. in diameter, $1\frac{1}{4}$ in. wide, and 4 in. bore, the faces of each being ground so that the joint will show as little as possible on the milled surface. In the other set there are four mills only or four blocks. Two of the blocks contain nine each of the corrugations, one eight,

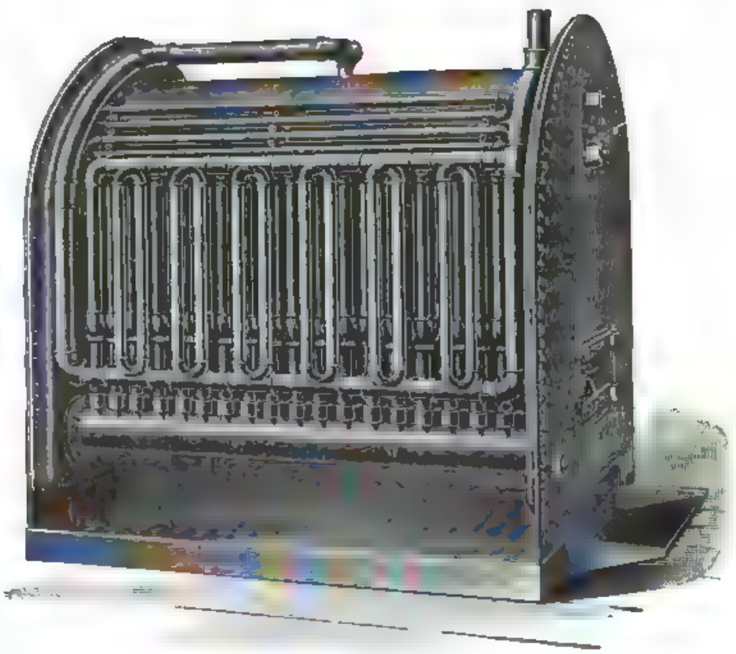


Fig. 2.

BOILER COMPLETE (WITH SIDE-CASING REMOVED) SHOWING DISPOSITION OF SUPERHEATING COILS: FROM PHOTOGRAPH OF A 50 HORSE-POWER BOILER.

and one seven, making the same number as the former set, and being the same dimensions otherwise. They are interlocked,

forming in effect a solid mill 38 in. in length, 8 in. diameter, and leaving a surface absolutely smooth. The cutting edge of each row of teeth in the blocks are set far enough back of the teeth in the preceding one, so that only one block or eight mills are cutting at one time.

"The plates are milled at the rate of about one an hour, including changing, and the mills being kept well lubricated, run from six to seven days without grinding.

"The machine in which these mills are operated and shown in illustration is built by the Pratt & Whitney Company, and known as No. 7 Double-Head Power Miller, and is probably the only machine built in this country capable of doing this work. It was designed and built to meet the requirements of work of this kind. It is built with either single or double-head, and provisions made for driving both heads together or separately as is necessary.

"The table is driven by a large and extra long worm-gearing with rack on under side; this worm is in halves, and is adjusted for taking up wear in threads; it has ball bearing collars on both ends for taking thrust.

"The spindle is of steel with tool steel thrust collars hardened and ground. The front bearings are 11 in. long and 5½ in. in diameter. Greatest distance between centers, 54 in.; least distance, 14 in. Greatest height, center of spindle above table, 25 in.; least height, 4 in. The table is 20½ in. wide, and the length the limit of its travel. The speeds are so arranged as to take cutters from 4½ to 18 in. diameter.

"The present work, while not showing the result in cubic inches of stock removed per minute, as in milling side-rods and like work, is probably the severest test the machine has been put to, owing to the great length between centers and amount of surface involved.

"The work has been watched with great interest by mechanics visiting the Company's works the past month, and astonishment expressed at the ease with which the work is done, the uniform smoothness of the milled surface, and the entire freedom from any evidence of chatter which might be expected in a gang of mills of this length."

Recent Patents.

BUTMAN'S FURNACE AND MECHANICAL STOKER.

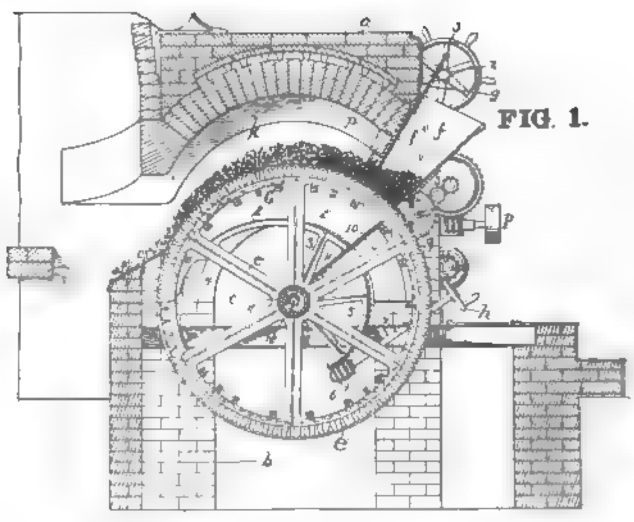
The object of this invention is to provide an improved furnace and an automatic self-feeding mechanical stoker. Fig. 1 shows a longitudinal vertical section of the furnace and apparatus. *a* indicates a suitable masonry casing of refractory material having an arch, *p*, which extends over the grate *G*. The construction of this grate is the novel feature. It is cylindrical in form, and consists of two large wheels, one of which, *e*, is shown in the engraving. These are loosely mounted on a hollow shaft, *c*, so that they can turn independently of it, and are placed at a distance apart equal to the width of the grate. The grate-bars are attached by their ends to each of the wheels.

The fuel is fed into the hopper *f*, the supply being regulated by a sliding door, *f'*. The grate is slowly revolved by gearing *s*, which is driven by a worm-wheel and pulley, *P*.

The combustion chamber *k* extends downwardly to what, in locomotive parlance, would be called the "forward" part of the grate or drum, to a point a short distance above its horizontal diameter, where it communicates with the up take and is provided with an inclined dump-plate or tail-piece, *o*. The inner edge of this is arranged in close contact with the surface of the grate, so as to scrape all ashes and clinkers therefrom.

Below the grate an ash-pan or air-controlling box is located within the cylindrical grate or drum, and is composed of the curved bottom 2, extending from a point at a distance from one side of the grate periphery over the shaft to the inner side of the grate-bars at the opposite side of the shaft and near the discharge from the combustion chamber and the vertical side plates 2', extending up from the side edges of said bottom upwardly to the inner surfaces of the rim of the grate head, so that a complete box or conduit is formed beneath the active surface of the grate, with an opening at the front end of said box at the front side of the grate. This box is supported by arms 3 extending upwardly from and rigid with the shaft and secured to said box, so that the box can be moved or rocked within the drum by rotating or turning the shaft. The inner or closed end of said box is provided with a shoe, 4, fitted and curved to conform to the curvature of the inner surface of the periphery of the grate, so that by rocking the hollow shaft the said box can be rocked to throw said shoe forwardly and rearwardly, and thereby decrease or increase the area of the grate to which air will be supplied from said box.

In fig. 1 the full active surface of the grate is shown supplied with air, as the shoe is located below the tail-piece over which the ashes are discharged; but if the rear end of the ash box should be rocked upwardly the said shoe would move up to a point above said tail-piece, and thereby shut off a corresponding area of the grate on which fuel is located from the supply of air passing in through said ash box. By this construction the air can be concentrated on the incandescent portion of the fuel or on the green fuel. Suitable means can be employed to rock the said shaft and pan. A toothed segment, 5, rigid with the said shaft and in engagement is shown with a worm, 6, carried by the inclined shaft 7, suitably journaled and extending forwardly to the front exterior of the furnace, where it can be provided with a suitable handle, *h'*, for rotating the shaft.



BUTMAN'S FURNACE AND MECHANICAL STOKER.

The ash box has the upwardly curving bottom, so that the area of the ash box gradually decreases rearwardly, which assists in throwing the air outwardly and upwardly through the grate-bars where the air is most needed—that is, at the point of greatest heat directly over the central portion of the drum.

The inventor says:

"The quantity of fuel consumed per hour can be readily regulated either by increasing or decreasing the speed of the grate drum; by increasing or decreasing the depth of fuel by means of raising or lowering the hopper gate; by means of the damper in regulating the admission of air to the fuel, or by placing the box in such a position as to increase or decrease the actual grate area supplied with air."

Mr. T. R. Butman, of Chicago, is the inventor. His patent is dated September 18, 1894, and numbered 526,341.

WORTHINGTON'S SECTIONAL STEAM-BOILER.

The object of this invention, shown in fig. 2, is to arrange the parts so that the furnace doors *I* may be located in the sides instead of the ends of such boilers, which arrangement will permit of the length of the boiler or the number of series of water tubes employed being increased to any reasonable limit, without in any way increasing the number of steam or water drums, the distance from the doors of the fire-box to the rear of the furnace, or the distance within which the firing or stoking of the boiler will have to be effected.

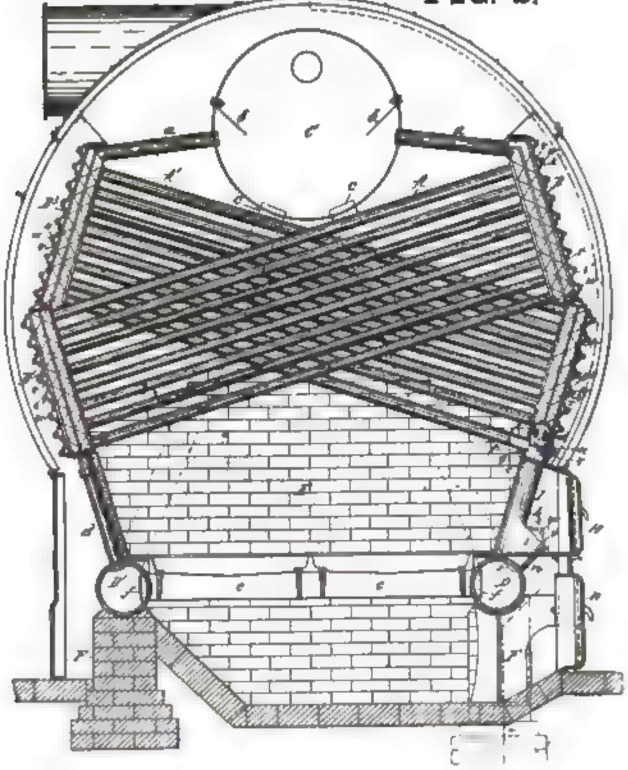
The invention is described as follows in the specifications:

"*A A'* indicate the water tubes, which, in my preferred form of construction, are arranged in series, with the individual tubes of each series disposed the one above the other, and *B B' B² B³* the water-tube headers, in which the ends of the water tubes *A A'* are respectively secured by expanding

the same in suitably shaped orifices formed therein. The series of water tubes *A*, with its headers *B B'*, are inclined to the horizon in one direction, and are alternated with the series of water tubes *A'*, which, with its headers B^2 B^3, are similarly inclined in the opposite direction. As thus disposed, the series of water tubes lie side by side in a horizontal direction, and the length of the boiler depends upon the number of series of water tubes arranged in that relation.

"Connected with the upper ends of the headers *B* B^3, by tubes *a*, is the steam and water drum *C*, which preferably extends throughout the entire length of the boiler, and is provided on its interior, over the ends of the tubes *a*, with deflectors *b*, by means of which the currents of water passing upward through such tubes will be deflected downward; while below the series of water tubes *A A'*, in positions substantially under their respective lower ends, and connected with the steam and water drum *C*, by down-flow tubes *c*, are water drums *D D'*, one of which, the drum *D'*, for instance, is connected with the lower end of the headers *B'* by tubes *d*.

FIG. 2.



WORTHINGTON'S SECTIONAL STEAM BOILER.

"Located under the water tubes *A A'* and steam and water drum *C* is the fire-box or furnace *E*, which is provided with suitable grate-bars *e*, that, as here shown, are supported at their ends by the water drums *D D'*, which connected by pipes *f*, preferably extended throughout the length of the boiler are, in turn, supported by suitable masonry piers *F*, or otherwise."

The patentee is Mr. Amasa Worthington, of Brooklyn, N. Y., and the number of the patent is 524,877, which is dated August 21, 1894.

HANNAN'S COAL-STOKER.

The inventor of this appliance, fig. 3, describes its object in the following long sentence:

"It is to produce a tilting coal-stoker mounted in a boiler front, into which the coal is shoveled, and in which the coal is more or less coked, before it is dumped onto the fire by the tilting of the receiver, so that more or less of the smoke-producing gases are eliminated before it is ignited; in which the tilting of the receiver, at least substantially, closes the opening in the boiler front, thereby preventing the indraft of a large quantity of cold air and the damages resultant therefrom to the fire, the flues, the heads, and the other parts of the boiler; in which the receiver when restored to its normal position after dumping tightly closes the opening in the boiler front."

Its construction is further explained as follows:

"*A* is a boiler front, and *a* is a boiler of any construction. Said front is provided with an opening, above the fire and front door, in which the coal-receiver *B* is mounted and adapted to be tilted, consisting of a metallic plate, *b*, which constitutes the bottom thereof, having its front end upturned to create the front *b'* of said receiver. Its inner end bears against the transverse wall or baffle plate *c*. Its top is closed

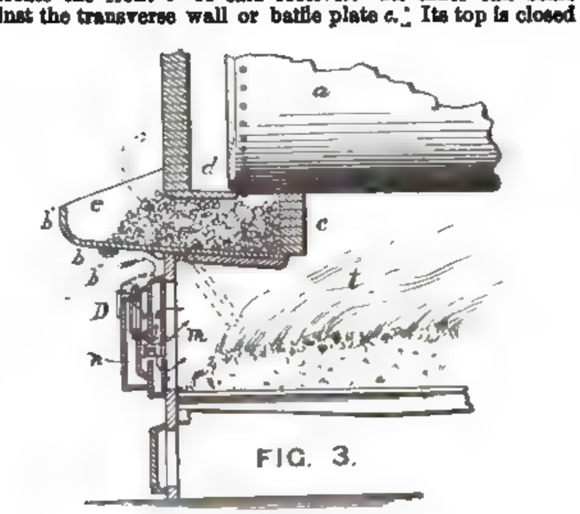


FIG. 3.

HANNAN'S COAL-STOKER.

by the plate *d*. The tilting bottom *b* rests and rocks upon the boiler front, and when tilted, as shown by the dotted lines, is supported by the lug *b''* upon the bottom.

"As the tilting of the coal substantially closes its opening in the boiler front, substantially all indraft of cold air is there prevented."

William H. Hannan, of Syracuse, N. Y., is the inventor. His patent is numbered 523,982, and dated August 7, 1894.

COLE'S METALLIC ROD-PACKING.

Mr. F. J. Cole, Mechanical Engineer of the Baltimore & Ohio Railroad, has patented the very ingenious form of packing shown in fig. 4. In describing his invention, he says that it is well known that in piston and other rod-packing, in which the metallic rings are pressed against the surface of the rod by being forced into a conical or other shaped cup having a tapered form, by means of a spring acting in the direction of the axis of the rod, that the rings frequently bind so tightly on the rod, due to roughness or slight irregularities in same, or by reason of a lack of oil, or by being too tightly forced

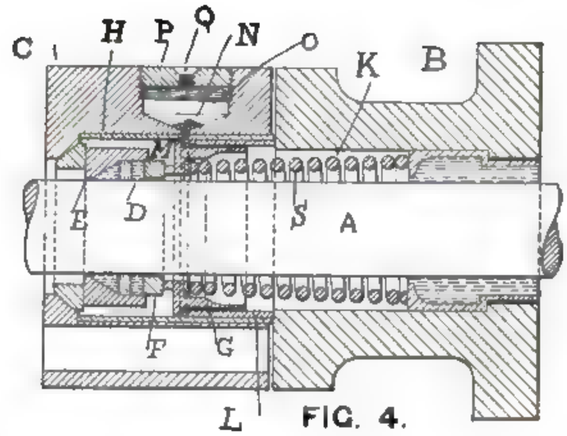


FIG. 4.

COLE'S METALLIC ROD-PACKING.

against the surface by the action of the spring, that instead of the rod sliding through them, the rings are carried back by the motion of the rod until the spring is entirely compressed, when it suddenly flies back to its original position, often causing the breakage of some of the parts, and nearly always resulting in unduly jamming the rings in the conical cup. In order to partially overcome this, it is customary to use an undue amount of spring pressure and increase its strength far in ex-

cess of what would be normally needed to keep the rings in sufficient contact with the rod to make a steam-tight joint. No provision has hitherto been made in this form of packing to automatically restrict this motion, and the object of this invention is to provide an abutment or stop which is automatically forced forward by the action of the spring, and blocked in its advanced position so that the metallic rings cannot be pushed out of position by the action of the rod.

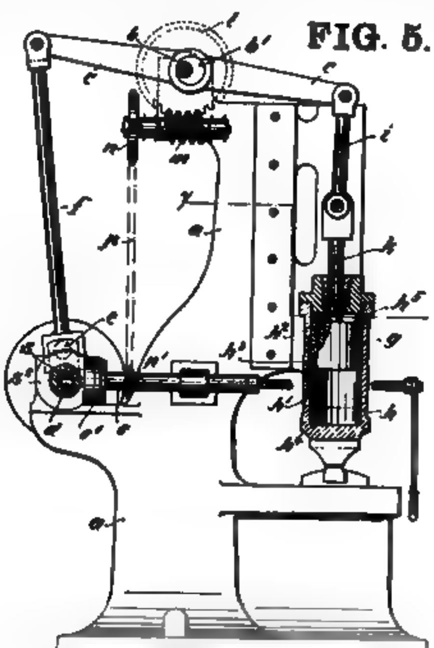
One of the methods of doing this is shown in fig. 4, which represents a section of a stuffing-box, packing rings, etc. *A* is the piston-rod; *B*, part of a steam-chest or cylinder-head; *O*, the packing case; *D*, the metallic packing rings; *E*, a conical-shaped cup which receives the rings; *G*, a movable abutment which bears against the packing rings, and on which the spring receives the rings; *G*, a movable abutment in contact with the ring *F*. *S* is a spiral spring which bears against a shoulder on the inside of *G*. *H* is an inside casing, and *L* a stationary abutment or sleeve which fits tightly inside of *H*. The movable abutment *G* has an outside collar, *M*. As the packing wears and the abutment *G* is pressed against the ring *F*, a little space is left between the collar *M* and the sleeve *L*. *O* is a receptacle which contains shot *N*. The space *O* has a small opening which communicates with the space between *L* and the shoulder *M*. As the packing wears and the space is increased the shot fall into it, and thus, by interposing a solid substance between *M* and *L*, prevents the axial movement of the packing rings.

In his specification Mr. Cole shows and describes several other methods of holding the packing rings in their place after they become worn, but the one described seems to be the preferable plan, and is certainly very ingenious. Mr. Cole's patent is numbered 526,381, and dated September 25, 1894. His address is Mount Clare, Baltimore, Md.

BÈCHÉ'S PNEUMATIC HAMMER.

This invention refers to pneumatic hammers, in which the hammer-head proper is formed by a heavy cylinder containing a piston, and in which this latter is employed for operating said cylinder or hammer-head; and the improvements relate to means for altering the height of stroke of the head, and also to means for automatically replacing the air for the upper air-cushion, if the quantity of the air of this cushion has become a too small one or has entirely been displaced.

FIG. 5.



BÈCHÉ'S PNEUMATIC HAMMER.

The frame *a* of the pneumatic hammer (fig. 5) holds on its top the shaft *b* in the two bearings $a' a^2$. Said shaft has an eccentric, *b'*, carrying the beam *c*. This beam may be oscillated from shaft *d* by means of a crank, *e*, and connecting-rod *f*, and transfers its motion to the piston *g* within cylinder *h* by means of the connecting-rod *i* and piston-rod *k*. In order to turn the eccentric *b'*, or, in other words, in order to raise or lower the beam *c* by means of the said eccentric, the shaft *b* has been provided with a worm-wheel, *l*, gearing with a worm, *m*. This latter is firmly connected with a chain-wheel, *n*, and may be turned from a sleeve, *o*, by means of chain-wheel *n'* and chain *p*.

The left-hand end of shaft *d* carries a sleeve, *s*, with two flange-like friction disks, only one of which, s^2, is shown, the rotations of which latter may be transferred on the sleeve *o* by the broad, disk-like end-piece *o'* of said sleeve *o*, so that by causing contact of disk *o'* with one or the other of the disks s^2 the worm-wheel *l* may be turned in one or the other direction, and the beam may thus be raised or lowered, just as required for a heavier or slighter blow of the hammer-head.

The differences in the height of the hammer-head caused by another position of the eccentric *b'* may well be seen from the engraving.

The interior space of cylinder *h* communicates with the outer air by means of two apertures $h' h^2$ connected at the inside of the cylinder by a groove or channel, h^3. The said apertures are situated some distance apart from the bottom and the cover, so that spaces $h^4 h^5$ are formed, in which some air may be kept back and compressed for forming cushions. If, now, the hammer moves with but slow speed, the air contained in space h^5 could by and by escape, as the head then moves with the same velocity as the piston. If, thereafter, a greater speed is chosen, a vacuum would arise above the piston, which, as a matter of course, can be of very injurious effect. To avoid this, an automatic valve formed by a ball has been arranged in the piston, said valve acting in such a manner that it allows the entrance of air into said space a^5, but hinders said air from escaping out of that space, so that, therefore, neither a vacuum nor even a rarefaction of air can happen.

The inventor is Jean Bêché, of Hückweswagen, Germany. His patent is dated September 25, 1894, and numbered 526,606.

BEAUDRY'S POWER HAMMER.

This invention relates to the class of power hammers wherein a reciprocating hammer-head is coupled to a crank which, by its rotation, imparts the reciprocating movement to the hammer-head, and particularly to that type of such hammer in which an elastic intermediary is placed between the hammer-head and crank, which enables the operator to give a stroke to the hammer somewhat in excess than that due to the crank alone.

In the hammer-head 3, fig. 6, is formed a socket, 3^a, to receive a Y-shaped piece comprising two spring-arms 9, 9, which have each a half-round shank which fits into the socket 3^a, a pointed screw, 10, serving as a set-screw to hold them firmly in place. Coupled to the crank-pin is a crank-rod, 11, and secured to this rod adjustably is a sleeve, 12, on which are two spring-branches, 13, 13. The lower ends of these spring-branches are coupled, respectively, to the upper ends of the spring-arms 9 by links 14, as shown in fig. 1. The rod 11, sleeve 12, and branches 13, 13 constitute a spring connecting-rod.

It is desirable where the hammer is to operate on pieces varying considerably in thickness to provide a means for varying the distance between the center of the crank-shaft and the lower face of the hammer-head, and this may be done by adjusting the shanks of the spring-arms 9 in the socket in the hammer-head, or by the adjustment of the sleeve 12 along the rod 11, securing the sleeve in place by means of a pointed set-screw, 15, which is driven into a longitudinal slit in the crank-rod so as to expand the latter in the sleeve and hold it fast therein.

When the crank-shaft rotates slowly the hammer-head will have given to it a stroke or travel about equal to the throw of the crank, but if set in rapid motion the momentum of the hammer-head acting through the spring-arms 9, the spring-branches 13, and links 14, will impart to the head a greater length of stroke, the spring connecting media being distensible longitudinally. The device will also serve to overcome gradually the inertia of the hammer-head at the ends of the strokes. The tension of the spring-arms and spring-rods may be increased by means of a tension-regulating screw, 16, which passes freely through one branch 13, and screws into the other, as clearly shown.

The inventor is Augustin Beaudry, of Somerville, Mass.; the number of patent is 526,370, which is dated September 25, 1894.

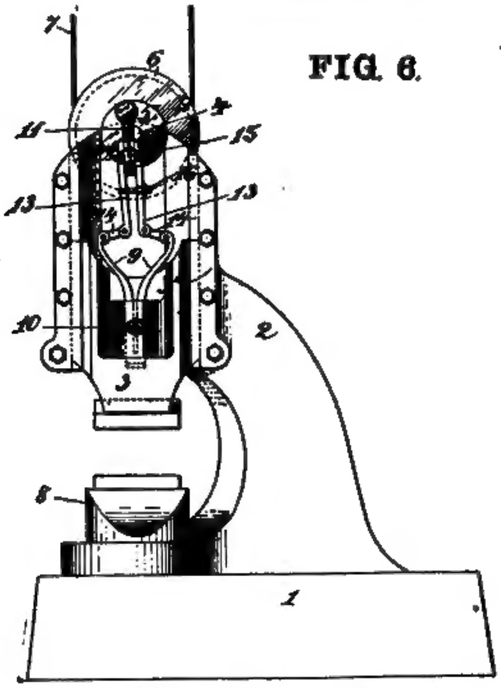
WARREN'S SHIFTING LINK.

Mr. William B. Warren, of Peoria, Ill., has patented the novel arrangement of link shown in fig. 7, which he describes as follows:

"My invention resides in the manner in which the outer ends of the eccentric rods are connected to the skeleton link, with relation to the saddle-pin 15, whereby a more perfect working of the parts is attained. To accomplish this object,

I first establish a center line, *A*, from which lines *B, B, C, C* and *D, D* are laid off perpendicular and at right angles to the center line, and these lines are equidistant apart on the center line. I then mark off lines *E, E* and *F, F* parallel with the center line and equal distances from the center line. I next locate the center *a* of the saddle-pin (which is the center of suspension and axis for link), where the center line and the center arc line *G, G* intersect with the center line *C, C*. I then locate the coupling-pin hole 10 at the intersection of the lines *E, E* and *D, D*, and locate the coupling-pin hole 11 at the intersection of the lines *B, B* and *F, F*, and I thus have the coupling-pin holes located at different distances from the main shaft and each located on a different side of the center arc *G, G*, and they are located at equal distances in a perpendicular measurement from the center of the saddle-pin 15, and are likewise located at equal distances in a horizontal measurement from the center of the saddle-pin, thereby forming a straight line, *H, H*, through the center of the saddle-pin, the coupling-pin hole 10, and the coupling-pin hole 11, so that the point of connection between the eccentric rods with the link 9 each travel an equal distance to or from the central line of motion at a movement of the link either along the center line

FIG. 6.



BEAUDRY'S POWER HAMMER.

of motion or rotation on its center of saddle-pin. I thus equalize and proportion to better advantage the angularity of the eccentric rods, thereby producing more correct and equal cut-off and exhaust of the openings in the main valve at all points of the stroke of the engine, and this is done without sacrificing the lead or admission openings of the main valve. By this arrangement also I am better able to locate the center of the saddle-pin on the center arc *G, G* of the link 9, thus reducing the slip of the link on its block, and reducing the strain and wear of all parts of the link-motion and doing away with the customary way of equalizing the main valve cut-off, and exhaust openings, which was done by locating the center of saddle-pin back of the center of arc *G, G*, and link, which caused slipping of the link on the block 12, resulting in wear and strain on the link-motion. These advantages are attained without complication, or without the use of more parts than usually employed in link-motions, and the improvement can be applied to all shifting link-motions in use, and at a small cost."

We will suggest to some of the younger engineers or draftsmen that an investigation, either on a model or diagram, of the merits of this design for a link would be interesting. It is not at all obvious that it possesses the advantages claimed for it. The patent is numbered 521,398, and dated June 12, 1894.

GÖLSDORF'S COMPOUND LOCOMOTIVE.

The patent for this invention, which is being introduced into this country by the Nathan Manufacturing Company, of New York, has recently been issued. It is, or should be, of so much interest to locomotive engineers that we give the description in full, which is published in the patent. The inventor describes his invention as follows:

"Hitherto it has been necessary, for the purpose of enabling compound locomotive engines to be started in whatever position the crank of the high-pressure cylinder may be at the time, to provide in the pipe or passage connecting the high-pressure cylinder with the receiver special closing or cut-off devices, such as cocks, valves, or dampers, that are operated, at the moment when the engine is to be started, in such a manner as to prevent the fresh steam supplied from the boiler and entering the receiver and low-pressure cylinder from exercising an injurious counter-pressure in the high-pressure cylinder on the side opposite to that in which the high-pressure piston moves when the distributing valve of such cylinder is closed.

"This invention has for its object to enable compound locomotive engines to be started without the employment of any special devices such as referred to, however unfavorable the position of the cranks may be at the moment; as, for example, when the crank of the high-pressure piston is nearly horizontal and that of the low-pressure piston is practically vertical. For this purpose the valve face of the low-pressure cylinder is formed with orifices or ports that are in communication with the main steam-pipe or boiler, and are so arranged that during the ordinary operation of the engine they will be effectually closed, while when the engine is to be started, in which case the ordinary working point of cut-off (corresponding to form about 50 to 60 per cent. of the piston stroke) is exceeded, one of these ports will be uncovered or opened whereby steam will be admitted to that end of the low-pressure cylinder corresponding to the required direction of motion, with the result that the low-pressure piston will be set in operation. From the steam-chest of the low-pressure cylinder the live steam passes into the receiver, and thence into the high-pressure cylinder entering on that side of the piston therein, which is opposite to that in which the movement of the piston ought to take place. Thus the steam entering the high-pressure cylinder will exercise a certain counter-pressure, which, however, will be overcome by live steam from the boiler as soon as the position of the cranks undergoes the slightest alteration, such live steam from the boiler entering direct into the high-pressure cylinder. When the low-pressure slide-valve assumes such a position that the port, which until then has been open, is closed, the direct admission of steam into the low-pressure cylinder will be discontinued, and

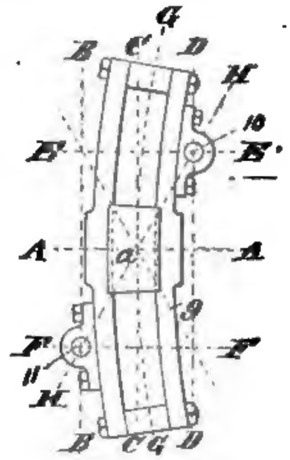
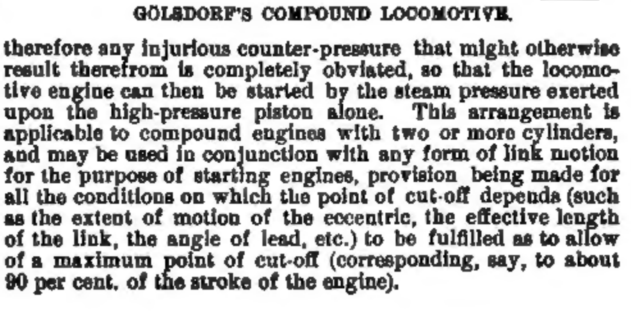


FIG. 7.

WARREN'S SHIFTING LINK.

FIG 8.



GÖLSDORF'S COMPOUND LOCOMOTIVE.

therefore any injurious counter-pressure that might otherwise result therefrom is completely obviated, so that the locomotive engine can then be started by the steam pressure exerted upon the high-pressure piston alone. This arrangement is applicable to compound engines with two or more cylinders, and may be used in conjunction with any form of link motion for the purpose of starting engines, provision being made for all the conditions on which the point of cut-off depends (such as the extent of motion of the eccentric, the effective length of the link, the angle of lead, etc.) to be fulfilled as to allow of a maximum point of cut-off (corresponding, say, to about 90 per cent. of the stroke of the engine).

"In order that the invention may be fully understood, reference is had to the accompanying drawings, in which fig. 8, a horizontal section, and fig. 9, a vertical cross-section of a compound locomotive engine, constructed in accordance with this invention. Fig. 10 is a plan to a larger scale, of the slide-

FIG. 9.

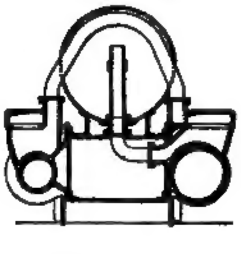


FIG. 10.

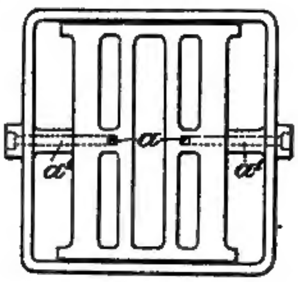


FIG. 12.

FIG. 11.

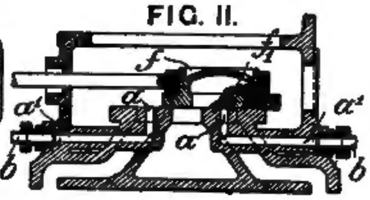
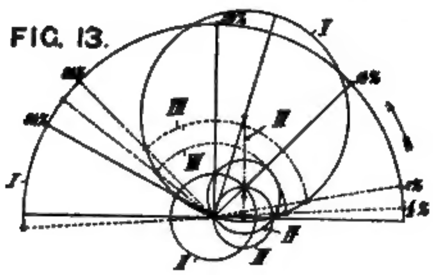


FIG. 13.



GÖLSDORF'S COMPOUND LOCOMOTIVE.

valve face of the low-pressure cylinder; and figs. 11 and 12 are respectively a longitudinal and transverse section of the valve-chest of the low-pressure cylinder. Fig. 13 is a diagram (on the Zeuner system) for a link-motion arranged in accordance with this invention.

"From the drawings it will be seen that the slide-valve face of the low-pressure cylinder is provided with two orifices or ports *a a*, that are connected by channels *a' a'* and pipes *b b* to a common pipe, *c*, that is in communication with a cross-pipe, *d*, and the main steam-pipe *d'*. The ports *a* of the said channels, *a'* are so arranged in the valve surface that in the ordinary operation of the engines, during which the point of cut-off does not exceed 50 or 60 per cent. of the stroke, they remain closed under the action of the piece or bridge *f'* of the slide-valve *f* for the low-pressure cylinder. When, however, the link arrangement is, for the purpose of starting the engine, adjusted for a larger point of cut-off (corresponding, say, to 90 per cent. or more of the stroke of the engine), one of the said ports will be opened (fig. 11) whereby steam will be admitted from the cross-pipe *d* to that end of the low-pressure cylinder which corresponds to the direction of motion of the piston at the time. When the ports are closed by the slide-valve *f*, the steam can no longer pass from the main steam-pipe *d'* and cross-pipe *d* into the low-pressure cylinder, and therefore no counter-pressure is produced upon the high-pressure piston. As, moreover, owing to the large point of cut-off, the position of the cranks is now the most favorable one, and inasmuch as the port *a*, which has remained closed up to this time, only opens when the piston stroke in the low-pressure cylinder changes, the link-motion may be absolutely relied upon for effective operation in starting the engine.

"The ports *a a* may be located at any other proper point in the face of the valve-seat, and in such relation to the valve as to be controlled thereby, and opened whenever the normal point of cut-off is exceeded, as above explained.

"The diagram of Zeuner, fig. 13, corresponds to a link arrangement fitted for a maximum cut-off (say, 94 per cent.) in accordance with this invention.

"In the diagram, I is the crank circle; II is the circle the radius of which equals the maximum overlapping; III is the slide-valve circle calculated for the minimum cut-off (14 per cent.); IV is the slide-valve circle for the medium cut-off (50 per cent); V is the slide-valve circle for the maximum cut-off; and VI is the line connecting all the slide-valve circles (the central curve).

"The distance between the two arcs of circles VII and VIII, drawn in dotted lines, equals the width of the ports *a* in the direction of motion of the slide-valve *f*.

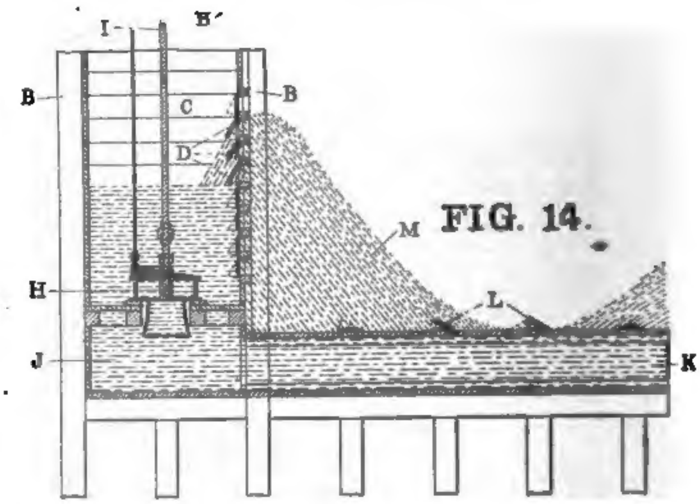
"It will be seen from the diagram that the ports *a* in the ordinary operation of the engine remain closed until a cut-off corresponding to about 50 per cent. of the stroke of the engin (which is the maximum under ordinary circumstances) is attained. When, however, the mechanism is adjusted for a cut-off corresponding to 94 per cent. of the stroke, one of the ports *a* will begin to open when the piston has completed about ½ per cent. of its stroke, and will be fully open when 2 per cent. of the piston stroke has been made. It then remains fully open until the piston makes about 85 per cent. of its stroke, after which the closing of the said port will begin. When the piston has made about 90 per cent. of its stroke the port will be completely closed again."

Mr. Karl Gölsdorf, of Vienna, Austria-Hungary, is the inventor. His patent is numbered 526,778, and dated October 2, 1894.

MERRITT'S WAVE MOTOR.

It has always been a mechanical mystery why the great power of the waves in large bodies of water has not been utilized more than it is. Mr. Charles A. Merritt, of Birmingham, Ala., has patented the contrivance shown in fig. 14, and of which he gives the following general description, from which and the engravings the construction will be understood without going into further detail:

"My invention relates to improvements in that class of wave motors in which the water from the top of a wave is stored at the highest point of the wave as a head to operate a turbine wheel, and the objects of my improvements are, first, to provide a penstock or storage reservoir to be constructed in or adjoining a wharf to receive the water from the tops of the waves, the penstock having free ingress for the water through a series of valves, the valves closing on the inside to retain the water when admitted; second, to provide a penstock of the above description with a turbine wheel to use as a motive power by which machinery can be driven on the wharf or top of the penstock for hoisting and other purposes required in the vicinity of wharves; third, to provide a tail race from the wheel for the escape of the water, the race in-



MERRITT'S WAVE MOTOR.

closed and extending at a right angle from the penstock, and having a series of valves placed on the top side of the race opening outwardly to permit the water to escape and prevent an inflow of water from the outside. I attain these objects by the construction and arrangement of the device illustrated."

NOTE.—Copies of any of the patents referred to above, or of any others in print, will be sent to any address on receipt of twenty-five cents in United States postage-stamps (not foreign stamps).

AERONAUTICS.

UNDER this heading we shall hereafter publish all matter relating to the interesting subject of Aerial Navigation, a branch of engineering which is rapidly increasing in general interest. Mr. O. Chanute, C.E., of Chicago, has consented to act as Associate Editor for this department, and will be a frequent contributor to it.

Readers of this department are requested to send the names and addresses of persons interested in the subject of Aeronautics to the publisher of THE AMERICAN ENGINEER.

WHY IS ARTIFICIAL FLIGHT SO DIFFICULT OF INVENTION?

By OTTO LILIENTHAL.*

IT is indeed difficult for man to flit through the realm of air with the freedom of a bird; but the longing to do so will allow us no rest. A single large bird circling over our head will renew in us the wish to soar like it in the firmament.

The mechanical instinct of even the average man is sufficient to perceive that we need but to find the right key to unlock for our use an entirely new portal of world-wide communication. Do we not see with what calm, with what complete assurance and wonderfully simple manœuvres yonder bird is gliding through the air? Can it be that man will never be able to accomplish as much?—man, with all his boasted intelligence and with all the mechanical aids that have enabled him to build truly marvellous works! And still it is difficult—I may say exceedingly difficult—to repeat even approximately what nature performs so easily. How many vain efforts have been made to imitate the bird! This, too, now that science has seriously taken up this question; that the phenomena of natural flight have been dissected, anatomically and mechanically, optically and by instantaneous photographs, as well as graphically by electric records. Now, at last, we have progressed so far that the bird cannot mislead us as to the theory, but in practice "he has the laugh on us." As soon as we try to utilize our dearly bought wisdom in actual flight, our lack of skill is painfully displayed; the swallows fly around our heads and twitter their derision. There is probably no other branch of engineering in which it is so difficult to find the right application of our theories in actual practice.

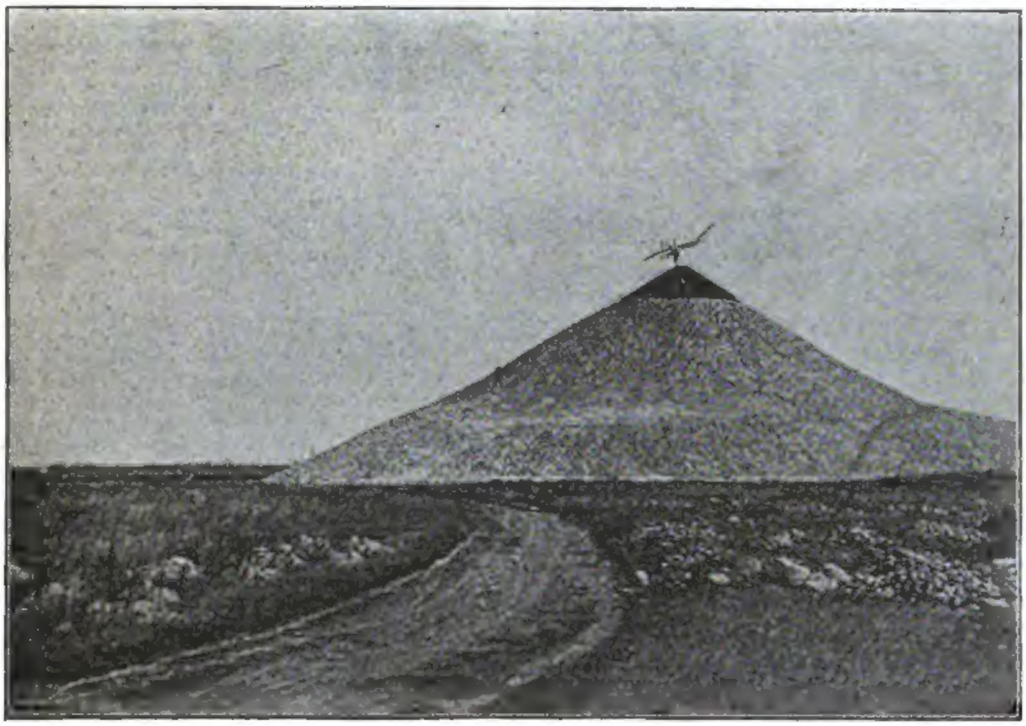


Fig. 1.

To-day we know very well what supports the flying bird; his wing cleaves the air at great speed, and by the slender curve of its profile compels the necessary sustaining reaction, even in this thin medium. The wind which passes under the widespread sail-surfaces of the bird undergoes a gentle deviation on the concave lower surface of the wing, which results in a sufficient "lift" when the wind is strong enough. The beating of the wing complements what the sail action alone does not accomplish.

To the untrained observer, it is true, when he sees the bird in flight, the movements of the wings seem to be simple up-and-down motions; but the aviator combines the wing beats with the effect of the velocity of flight and the movement of the air, and concludes that even in rowing flight, especially for the larger birds, the carrying surfaces cut the air at a very acute angle, and that in rapid forward flight even a gentle depression of the wings produces much carrying power with little expenditure of energy.

This, therefore, is the action to imitate, this rapid forward motion, with slow beating of the wing—at least, this is what nature teaches us; but it is only in case that the process is carried on with absolute correctness that we may hope to fly in this way. If anything be omitted or incorrectly done, the whole undertaking will fail.

Whether this direct imitation of natural flight is one way out of many which will lead us to the goal, or whether it is the only way, is to-day still a mooted question; many aviators, for instance, consider the wing motion of birds too difficult to imitate mechanically, and they dislike giving up for aerial propulsion the screw propeller, which has been found so useful in the water. On one point, however, they are agreed, and that is that we must fly at high speed if we are to fly at all, and this requirement is a dangerful difficulty in the invention of artificial flight.

It is universally admitted to-day that man will not be able to rise vertically in calm air from a position of rest; no more can the large birds do so, because the expenditure of energy must be enormous. Designers of flying machines, for this reason, now arrange their apparatus so as to begin to rise with a considerable horizontal motion.

Although most projects of the kind are based upon the principle of bird-flight—*i.e.*, the supporting power is obtained by sail-surfaces rapidly moved forward—still the methods of reproducing natural flight by mechanical means are as various as the aviators who undertake the experiments, each man going his own way; but all these separate ways yet lead to one and the same reef, on which the conception and often the ingenious vessel itself is wrecked before it can be utilized for the intended purposes. Indeed they rarely, without breaking the machine, get beyond the first trial, which usually results in the failure to rise into the air at all, or at best to get back to the earth very quickly.

What it means to be whizzing through the air with the velocity of an express train, and then to come back to the ground without danger and without breaking the apparatus, it is not difficult to conceive. If this trick is to be done with a large, heavy, and complicated machine, the prospect of alighting

* Translated from *Prometheus*, No. 261, Berlin.

safely is, of course, much less. It seems really preposterous to count on success in the first trials with such complicated machinery; for this reason the reviewer in No. 259 of *Prometheus* is quite right in his statement that, by experimenting

Fig. 2.

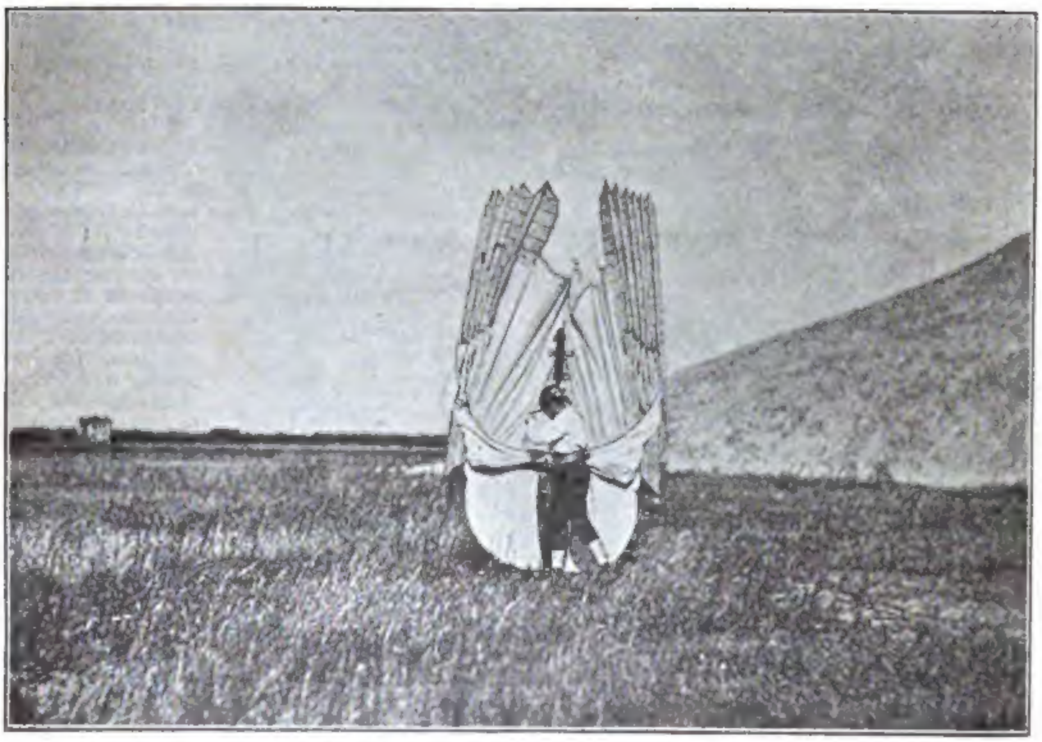


Fig. 3.

with large machines, the expense of the tuition, which we must surely pay before we learn how to fly, is uselessly increased. Maxim's flying machine, the one alluded to in the above-mentioned review, has cost a very large sum of money, and this distinguished inventor deserves high praise for having devoted so much to aviation, the hitherto Cinderella of engineering science; but, after all, the result of his labors has only been to show us "how not to do it."

This celebrated example may suffice to demonstrate that the most ingenious machinery, even when combined with powerful and very light motors, will not alone solve this intricate problem. Maxim's experiments also prove the truth of another view, which I have alluded to at every opportunity: that, in point of fact, the real destroyer of this machine, weighing 8,000 lbs., was a gentle wind gust, which, in consequence of the enormously large wind surfaces, produced a very great force. The machine could not fail coming to grief, and it will invariably come to grief whenever it is used even in a moderate wind.

Now, which one of all the inventors of such apparatus has the proper conception of the mercilessness of the wind toward all flying machines? This brings up a new difficulty in the invention of artificial flight. I myself have often enough been the plaything of the wind, when I was taken unawares during my experiments by wind gusts; suddenly I was raised the height of a house and tossed back and forth, so that I was breathless until I got used to the sensation. In such experiments one cannot fail to become an air-gymnast in the boldest sense of the word, and I may therefore be permitted to express my opinions on the action of the wind on aeroplanes, and on the best way of counteracting its destructive force.

Herr *Anschütz*, on September 14th of this year (1894), availed himself of an opportunity of taking some photographs of my exercises in windy weather. The illustrations, figs. 5 and 6, reproduced from his instantaneous views, show what gymnastic feats are necessary to keep from being thrown from the saddle in such a squally ride through the air, and to bring back, furthermore, the flying outfit safely to mother earth. These factors cannot possibly be neglected by any one who tries to direct an aerial vehicle through moving air.